

ORDER

6480.7D

**AIRPORT TRAFFIC CONTROL TOWER AND
TERMINAL RADAR APPROACH CONTROL
FACILITY DESIGN GUIDELINES**



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**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

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Initiated By: ATB-300

FOREWORD

This order sets forth guidelines and fundamental requirements for design of airport traffic control towers (ATCTs) and terminal radar approach control (TRACONS) facilities to be used by engineers, designers, planners, and procurement personnel engaged in the establishment, replacement, or modernization of these facilities. This issue incorporates changes to Order 6480.7C, Airport Traffic Control Tower and Terminal Radar Approach Control Facility Design Guidelines, dated 28 April 1995, necessary to bring it up to date.



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Vice President for Terminal Services, ATO-T

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CHAPTER 1. GENERAL

SECTION 1. INTRODUCTION

1. PURPOSE . This order establishes guidelines and fundamental design requirements for airport traffic control tower (ATCT) and terminal radar approach control (TRACON) facilities.

2. DISTRIBUTION. This order is distributed to division levels in Airway Facilities, Air Traffic, Office of System Architecture and Investment Analysis, and the Terminal Business Service in Washington headquarters; to division level at the Mike Monroney Aeronautical Center and the William J. Hughes Technical Center; to the branch level in the regional Airway Facilities (AF) and Air Traffic (AT) divisions; and a standard distribution to all Airway Facilities field offices.

3. CANCELLATION. Order 6480.7C, Airport Traffic Control Tower and Terminal Radar Approach Control Facility Design, dated 28 April 1995, is canceled.

4. EXPLANATION OF CHANGES. This revision extensively updates Order 6480.7C. The update resolves inconsistencies between this order and other reference documents; e.g., the International Building Code (IBC), FAA Acquisition Management System (AMS) and applicable Federal Aviation Administration (FAA) orders; and incorporates clarifications and elaborates on other items suggested by reviewers since the issuance of 6480.7C on 28 April 1995; and to provide a consistent format. "Shall" remains the operative word and is defined in paragraphs 5 and 22. Major and minor changes include the following subjects:

- a. Site security requirements.
- b. Electrical, mechanical, and structural design requirements.
- c. Environmental requirements.
- d. Disabled access requirements.
- e. Seismic- and weather-related requirements.
- f. Remove reference material direct quote requirements.
- g. Corrected numerous editorial oversights.
- h. Updated reference materials and refer directly to reference documents by paragraph number and general requirements.
 - i. Added the IBC document as reference.
 - j. Added the FAA AMS and the Integrated Product Development System (IPDS).

5. APPLICABILITY. This order shall be used to establish new ATCTs, TRACONs, and ATCT/TRACONs and existing facility relocation or upgrade projects. All projects, ATCT/TRACON standard design site adaptations, and custom designs, are subject to these standards.

a. The figures in this order addressing facility layouts are intended as representative examples and should not be construed as design requirements.

b. The use of "shall" in this document indicates a condition, situation or technical parameter that the procuring organization shall address and define in the appropriate procurement documents, i.e., Screening Information Request (SIR), Statement of Work (SOW), Specifications, etc.

c. In selected cases, it may not be prudent or practical to implement certain requirements set forth in this document. When necessary, these deviations shall be documented and approved by the designated approval authority.

6. REQUESTS FOR INFORMATION

a. Requests for further information concerning this directive should be forwarded to:
Terminal Business Service, ATB-300
800 Independence Avenue, SW
Washington, DC 20591

b. Changes will be made to this document whenever there are sufficient new items or modifications.

c. Employee suggestions and unsatisfactory condition reports (UCRs) will be used as information sources for changes.

d. Letters covering new or modified items may also be sent through normal channels to:

Airway Facilities Comments:	Air Traffic Comments:
Terminal Business Service	Air Traffic System Development
Facilities Division, ATB-320	Directorate, ARU-1
800 Independence Avenue, SW	400 Seventh Street, SW
Washington, DC 20591	Washington, DC 20590

7. OBJECTIVE. The objectives of this order are as follows:

a. Combine into one source, either directly or by reference, all current data pertaining to ATCT/TRACON designs.

b. Establish the minimum ATCT/TRACON project design criteria.

c. Provide guidance that will promote facility design consistency and uniformity.

8. SCOPE. This order provides general guidance and includes specific requirements on planning, materials, aesthetics, economics, functional requirements, future expansion

capabilities, and other information necessary to provide the designer with complete guidelines for ATCT/TRACON design.

9. ORGANIZATION. This order is divided into nine chapters that address ATCT/TRACON facilities design criteria/requirements. Definitions, acronyms, and generic tower drawings are included in the appendices.

10. REFERENCES. A complete list of documents referenced in this order is provided as Appendix 1 Referenced Publications. The design and procurement process shall use the latest version of each referenced document. Procurement and construction contracts shall specifically list and use the version in effect as of the date of contract signing.

a. Specific web site addresses were not used in this document to avoid frequent conflicting address changes. Contact the subject organization or use the available search engines to find the specific web site for the subject discussed.

SECTION 2. ATCT/TRACON DEVELOPMENT PROCESS

11. PRELIMINARY CONSIDERATIONS. Prior to the initiation of formal ATCT/TRACON design activities including runway and airport building ten-year expansion, extensive planning shall be completed to include:

- a. Preliminary requirements analysis.
- b. Budget development process and cost requirements.
- c. Project establishment and life-cycle cost data analysis. Facility life-cycle costs shall be minimized and best value solutions implemented.
- d. Determine facility design criteria.
- e. Develop site selection and real estate acquisition process.
- f. Outline employee involvement with site personnel and labor representatives.
- g. Applicable publications and documents.
- h. Facility staffing and equipment requirements.
- i. Control cab height.
- j. Review “lessons learned” from recent tower designs and construction.
- k. Utilize the Airport Traffic Control Tower Cab simulator, William J. Hughes Technical Center Airway Facilities Tower Integration Laboratory (AFTIL) to model cab and out-the-

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window views of runways, taxiways, lights, buildings, terrain, and various skylines in addition to moving aircraft and ground vehicles.

1. Human factors. Operations, maintenance, FAA Human Factors Design Guide, and working environment.

12. BASIC POLICY DIRECTIVES. Specific ATCT/TRACON development and design direction is also provided by basic policy directives. These directives shall automatically become part of an ATCT/TRACON design. Directives in effect at the publication of this order are listed in Appendix 1 Referenced Publications.

13. OVERVIEW OF THE DEVELOPMENT PROCESS. The design process is one of several steps in the overall planning and establishment process for an ATCT/TRACON. Figure 1-1. ATCT PLANNING AND ESTABLISHMENT PROCESS illustrates the major components, planning, and establishment design process steps.

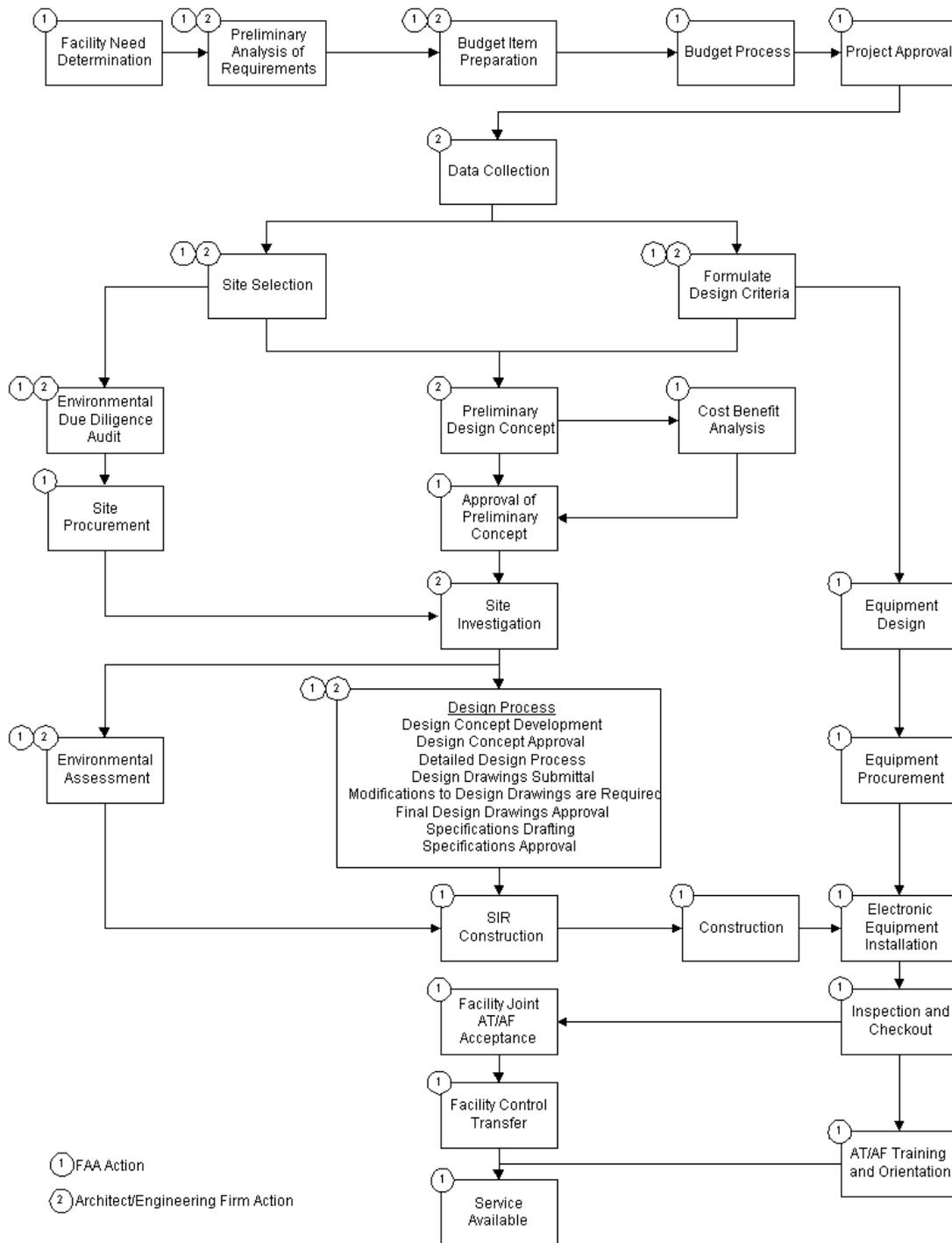


FIGURE 1-1. ATCT PLANNING AND ESTABLISHMENT PROCESS

SECTION 3. PROJECT PLANNING

14. DATA COLLECTION. The early design planning involves past data accumulation to determine the present facility requirements, as well as future plans and requirements, generally projecting at least ten years past facility commissioning.

a. The designer may obtain preliminary information from the designated approval authority (see the ANI [National Airspace System Implementation Program] SOP web site on the FAA intranet).

b. Refer to CHAPTER 2 for background information and guidance on the principal factors that influence the ATCT/TRACON designs.

15. FORMULATE DESIGN CRITERIA. Following the project's approval for funding, data collection is begun and the process of formulating the basic design criteria is initiated.

a. The information provided in Chapters 2 and 3 will aid the designer in formulating design criteria.

b. The formulation of the design criteria process runs concurrent with the site selection process.

16. PRELIMINARY DESIGN CONCEPT. After determining the facility needs and identifying environmental conditions affecting the project, the designer can develop a preliminary design concept that encompasses building configuration and site layout when applicable. The preliminary design concept will be subject to approval by the designated approval authority before detailed design can proceed.

17. DESIGN GUIDELINE WAIVERS. Waivers to specific facility design guidelines will be considered with sufficient justification and alternate design detail. A waiver request, in writing, to ATB-300 must be completed for any deviation to these facility design guidelines. The waiver request must include enough information to enable a management decision on the request. At a minimum, the request must include the subjects listed below. Before beginning the waiver request, direct communications with ATB-320 are suggested to define detail and facilitate the submission and approval process. Additional submission details may be negotiated between ATB-300 and the requesting organization.

- a. Specific design guideline requirement affected.
- b. Alternate design description.
- c. How does the alternate design meet the original requirement intent?
- d. Cost/benefit analysis for the change.
- e. Schedule impact to complete the new design.

- f. Impact to project if waiver is approved/disapproved.
- g. Additional factors determined by ATB-320 and the requesting organization.

SECTION 4. IMPORTANT CONSIDERATIONS AND REQUIREMENTS

18. ENVIRONMENTAL IMPACT. Compliance with the National Environmental Policy Act (NEPA) of 1969, Public Law 91-190, is an integral component of the FAA comprehensive environmental responsibility.

a. An Environmental Assessment in accordance with Order 1050.1, Policy and Procedures for Considering Environmental Impacts of Proposed FAA actions, shall be prepared in conjunction with site selection.

b. Further consideration shall be given during the site design process to ensure that the specific project imposes the minimum adverse impact on the natural and human environment.

19. INTERGOVERNMENTAL REVIEW OF FEDERAL PROGRAMS. The design shall comply with Executive Order 12372 requirements. This Executive Order, based on the Intergovernmental Cooperation Act of 1968 and the United States Code, Title 3, Section 301, fosters an intergovernmental partnership. Further, it strengthens the FAA establishment program by relying on State and local processes for the State and local government coordination and review of proposed Federal financial assistance and development. Order 1200.21, Intergovernmental Review of FAA Programs and Activities Guidance provides requirements.

20. ENERGY CONSERVATION.

a. The designer shall:

1) Consider minimizing ATCT/TRACON life-cycle cost by utilizing energy efficiency, water conservation, and solar or other renewable energy technologies. Refer to FAA-STD-033, Design Standards for Energy Management in National Airspace System (NAS) Physical Facilities, for energy management guidance.

2) Comply with 10 CFR 436 life cycle costing procedures.

3) Ensure the design and construction is in compliance with Executive Order 13123, Greening the Government Through Efficient Energy Management, Order 1053.1, Energy and Water Management Program for FAA Buildings and Facilities, and the 1992 Energy Policy Act.

4) Meet or exceed the 10 CFR 435 and other national or local energy performance standards applicable to Federal residential or commercial buildings that may be more cost effective over the life of the facility.

5) Utilize passive solar design, such as day lighting and adopt active solar technologies,

where cost effective.

b. Additionally, the designated approval authority should provide the designer with other documentation, as appropriate, which describes energy efficiency and water conservation products and services that might be available from other Federal Agencies; i.e., Department of Energy (DoE), General Services Administration (GSA), or the Department of Defense (DoD).

c. Refer to paragraph 20 for additional guidance on energy conservation. The energy conservation requirements do not override equipment reliability, health, and safety requirements.

21. CODES. Code requirements set forth in this order are to be considered the standard for ATCT/TRACON designs. References to codes in this order are intended to provide guidance where specific requirements are not otherwise expressly addressed herein.

a. FAA national standards shall meet applicable Order 3900.19, National Electrical Code (NEC) requirements, Occupational Safety and Health Administration (OSHA), National Fire Protection Association (NFPA), FED-STD-795, 29 CFR 1960.20, and IBC code requirements. Site-specific designs shall follow these recognized national codes and applicable local codes.

b. The latest version of all orders, standards, specifications, and codes shall be used to design facilities. Executive Order mandated design requirements shall be followed.

c. The more stringent reference document requirement shall be used when multiple documents are referenced.

d. The Spectrum Assignment and Engineering Division, ASR-100, and the Environmental Energy and Safety Division, AFZ-800, shall be consulted on radiation hazard issues at new facilities, from proposed or existing sources of electromagnetic radiation (i.e., near-by radar systems).

22. DEVIATIONS FROM STANDARDS. The use of the word "shall" in this document represents a requirement and indicates a condition, situation, or technical parameter that will be adhered to.

a. Deviations from the standards set forth in this order may be approved only if they exceed the minimum requirements.

b. All deviations shall be approved and recorded by the designated approval authority.

23. PROJECT DOCUMENTS. All project documents; i.e., plans, calculations, reports, specifications, and design notes, shall be prepared in accordance with standards FAA-STD-002, Federal Aviation Agency Standard for Engineering Drawings; FAA-STD-005, Preparation of Specification Documents, and ANI-Standard Operating Procedures (SOPs).

a. The project documents shall be prepared in FAA-approved electronic format and shall be compatible with existing FAA electronic resources.

b. Final plans, specifications, design notes, and record drawings will become a permanent part of the project file.

c. It is the designated approval authority's responsibility to assure that the required documents are included in the project file.

d. The latest version of any reference document quoted herein is to be used unless specifically directed otherwise by this order.

24. SECURITY. ATCT/TRACON security requirements shall be prescribed and implemented to a degree that is consistent with vulnerability, imminent threat, and facility criticality. Paragraph 302 describes FAA security system requirements.

a. A security risk analysis/threat assessment shall be conducted to determine the criticality, vulnerability, and threat associated with the assets and grounds under FAA control to be protected.

b. A security risk assessment report shall be prepared and used as part of the design process to ensure individual site security requirements have been met. The elements of this risk assessment shall include but not be limited to automated information management, operation, physical, personnel, and information security.

c. The risk analysis shall be used as the basis for determining the methods of access control and the remote monitoring techniques to be employed at each site. Access requirements shall be determined for all telco and vendor controlled spaces.

d. As a minimum, all ATCTs/TRACONs shall be designed to feature access control using, for example, keys, electronic card entry systems, or cipher locks.

e. Capability to remotely monitor facility grounds from a cab or TRACON position using direct visual monitoring or the use of motion sensors or the use of closed circuit television (CCTV) monitors shall be provided.

f. Facility access and delivery drop-off requirements shall be determined for all delivery vehicles and personnel.

g. Security considerations should be addressed during planning, site selection, and design to ensure that all security requirements are met. Order 1600.6, Physical Security Management Program, provides general physical security policy. Order 1600.69 provides specific guidance on physical security requirements by security level for each facility type. The Orders also establish procedures to ensure compliance with public laws, national security directives and policies, and Department of Transportation (DoT) orders. For additional information concerning security requirements, refer to paragraphs 79 and 302.

CHAPTER 2. BASIC DESIGN CRITERIA

SECTION 1. GENERAL

25. INTRODUCTION. This chapter outlines the basic criteria that shall be evaluated and analyzed prior to starting the design effort. Some criteria have fixed parameters, but in many instances the parameters are variable and will need to be determined and approved by the designated approval authority for a specific ATCT/TRACON facility.

a. **Human Factors.** The ATCT/TRACON facility must consider the implications of operational requirements and task performance on design, and the impact of the design on human performance of operations and maintenance tasks.

b. Human factors considerations should include, but not be limited to, varied staffing levels (high and low); anthropometrics; alternative equipment designs and configurations; training and training equipment requirements; accessibility for those with disabilities; operator work space and access requirements for ease of maintenance; general and task lighting; storage space and use of special tools, manuals, and job aids; safety and health considerations; the environment for necessary visual and audio alerts; and individual and team procedures along with necessary communications (visual and aural). These human factors considerations should be addressed during the early stages of the design and development of the facility, assessed during structures evaluations and tests, and conform to architectural and human factors best practices including those specified in FAA Human Factors Design Guide (DoT/FAA/ACT-96-1) and the FAA Human Factors Job Aid.

SECTION 2. AIR TRAFFIC CONTROL RESPONSIBILITIES

26. ATCT/TRACON CLASSIFICATIONS. Airport traffic control towers are classified into categories designated by the Position Classification Standard for Air Traffic Control, Series ATC-2152. Actual classification level is determined on a facility basis by air traffic management.

a. These categories are based upon the ATC-2152 Position Classification Standard, Part I, Terminal Positions. The ATC categories are listed in Table 2-1. The distinction levels are used to establish personnel requirements and are useful data for other design purposes. It is important for the designer to review the current and projected air traffic activity and complexity levels in order to formulate project scope. Coordination with local and regional Air Traffic organizations is essential.

b. Other major factors establishing project scope are equipment type, agency space standards and policies, airport configuration, automation equipment, personnel requirements, facility complement, and growth rate.

c. These factors may combine to create distinctive design requirements. However, some can be grouped and used to establish design classifications.

d. Currently, there are three nominal ATCT/TRACON design classifications: (1) Low Activity, (2) Intermediate Activity, and (3) Major Activity. Elements affecting design classification are listed in Table 2-2.

e. Provide 25 percent unassigned equipment growth space in ATCT equipment rooms and TRACONS unless the allocation conflicts with local requirements. Growth space shall be fully supported by electrical power system, HVAC system, etc. This shall be included in the spare 25 percent capacity of these systems.

f. The Terminal Area Forecast data at the FAA-APO web site (<http://www.apo.data.faa.gov>) has past, present, and projected air traffic activity data.

TABLE 2-1. AIRPORT TRAFFIC CONTROL TOWER ACTIVITY LEVELS

Terminal Types					
Terminal Level		Non-Radar Approach VFR Tower	Non-Radar Approach	Limited Radar Approach	Radar Approach
New Levels	Old Levels				
*	I	0 - 34.9	0 - 24.9	---	---
*	II	35 - 89.9	25 - 79.9	0 - 24.9	0 - 19.9
*	III	90 or more	80 or more	25 - 59.9	20 - 59.9
*	IV	---	---	60 or more	60 - 99.9
*	V	---	---	---	100 or more
Traffic Data Used		Airport Operations	Airport Operations and Instrument Operations	Instrument Operations	Instrument Operations
CRITERIA: Hourly Traffic Density Factor (sum of daily traffic for the busiest 183 days of the last 365 days, divided by 183 days, divided by 16 hours or actual hours of operation if a facility is open less than 16 hours). Traffic data to be used is determined by facility type.					

*See Position Standard ATC-2152, Appendix A for specific facility level.

TABLE 2-2. ATCT/TRACON DESIGN CLASSIFICATIONS

DESIGN ELEMENTS	DESIGN CLASSIFICATIONS			
	LOW ACTIVITY	LOW ACTIVITY RADAR	INTERMEDIATE ACTIVITY	MAJOR ACTIVITY
Control Cab Size	Over 220 SF	Over 350 SF	Over 350 SF	Over 500 SF
Tower Height (to Cab Floor)	Up to 97 ft.	75 – 99 ft.	Up to 141 ft.	Generally 120 ft. and over
Radar/Automation Equipment for TRACON	None	ARTS II/IIA or III/ IIIA, STARS	ARTS II/IIA or III/ IIIA, STARS	ARTS III/III A, STARS
Number of Radar Systems	None	1	1 or more	1 or more
Planned Radar Positions	None	Up to 6	Up to 10	10 or more

27. AIRSPACE CONTROL JURISDICTION. The designer shall consider relative equipment and space size requirements for ATCT/TRACON jurisdictional responsibilities over other satellite airports. The following functions where the ATCT/TRACON jurisdictional requirements shall be considered early in the design process are:

- a. VFR traffic separation.
- b. IFR approach control.
- c. Radar advisory service.
- d. Tower service, vectoring and sequencing.
- e. Tower en route control.
- f. Air traffic system safety.
- g. Air traffic system flexibility and delays.
- h. System user access and productivity.

28. ESTABLISHMENT CRITERIA. See Order 7031.2, Airway Planning Standard Number One - Terminal Air Navigation Facilities and Air Traffic Control Services for the detailed criteria involved in establishing ATCT facilities with or without TRACON facilities.

SECTION 3. AIRWAY FACILITY BUILDING REQUIREMENTS

29. EQUIPMENT MAINTENANCE. Special emphasis shall be placed on providing safe, adequate access to tower equipment for routine and emergency maintenance. Proper working areas around equipment and testing requirements for:

- a. Heating, ventilating, and air conditioning (HVAC).
- b. Electronic equipment.
- c. Engine generators.
- d. Power conditioning systems (PCS).
- e. Uninterruptible power systems (UPS).
- f. Elevators.
- g. Electrical cab hoist.
- h. Environmental control and monitoring system (ECMS).
- i. Direct Digital Control (DDC) system.
- j. Prepackaged engine generator location.
- k. Other special mechanical systems.
- l. Lighting.
- m. Equipment hoists.
- n. Electrical cabinets.
- o. Compressed air supplies.
- p. DC power supplies.

30. FACILITY MAINTENANCE. Special consideration shall be given to the maintenance aspects of materials, finishes, space layout, etc.

a. Primary consideration shall be given to the use of low or no maintenance materials. Maintenance equipment storage space shall be provided in convenient locations.

b. Some facility areas (i.e., tower cab) require special design attention. These areas include loading docks and other project operational material transfer devices.

- c. Building landscaping shall consider low maintenance designs.

31. POSSIBLE ADDITIONAL ACCOMMODATIONS. Airway Facilities field personnel responsible for remote field facilities on the airport are frequently assigned to, and located at, an ATCT/TRACON facility. In some special cases, an entire field maintenance organization may be located in the facility, which may require additional office, electronics, and environmental workshop storage space and may also include special requirements, such as remote maintenance and monitoring (RMM) and computer-based instruction (CBI) equipment. These requirements shall be determined by the designated approval authority in accordance with AMS Policy (with Order 4420.4, Space Acquisition, treated as a historical document) and shall be evaluated early in the design planning process to assess the facility special use impact. See the Administrative Space Standard in the Federal Aviation Acquisition Management System Toolset (FAST) for additional space guidance.

32. - 33. RESERVED .

SECTION 4. SPECIAL REQUIREMENTS

34. STAFFING AND SPACE RELATIONSHIP. The personnel and space arrangement required for safe and efficient facility operation is a major factor influencing the ATCT/TRACON design.

- a. The relationship of some spaces affected by special equipment is critical, while other space relationships are desirable for convenience only.
- b. In all cases, administrative office space shall be designed to provide maximum use and accommodate common space sharing by all FAA organizations.
- c. See the Administrative Space Standard in FAST for additional space guidance.

35. VARIATIONS IN EQUIPMENT AND INSTALLATION.

a. Individual ATCT equipment inventories are very flexible. In addition, the equipment state-of-the-art design is constantly changing. Several major replacements or additions to electronic equipment should be anticipated during the facility life.

- 1) The equipment actually installed may not include all of the items originally intended.
- 2) Some flexibility and future equipment space allowance shall be incorporated into the building design. Use 25 percent growth margin unless specific known growth establishes a different percentage.
- 3) Future airport plans and current and future equipment space requirements should be based on an FAA-approved facility equipment forecasting database; e.g., facility requirements database (FRDB).

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4) In general, replacement systems should not occupy more space than the systems they are replacing.

5) Due to age, activity, and growth rate, wide variations exist in the type and quantity of equipment currently installed in ATCTs and TRACONs.

6) In general, the complexity and quantity is proportional to the facility's activity level. As the activity level designation increases, the complexity of equipment increases.

b. Equipment installed in any ATCT/TRACON is dependent upon the specific needs at that location. For this reason, a typical equipment list cannot be assumed for any activity level. However, a representative equipment list illustrating the generic equipment package normally associated with each design classification can be utilized as preliminary guidance as shown in Table 2-3. The designated approval authority shall approve the final equipment detailed planning list. Table 2-4, Table 2-5, and Table 2-6 provide the designer with a general idea of the basic special equipment requirements at ATCTs and TRACONs in each design classification.

TABLE 2-3. REPRESENTATIVE EQUIPMENT LISTING

EQUIPMENT	QUANTITY		
	MAJOR ACTIVITY	INTERMEDIATE ACTIVITY	LOW ACTIVITY
A. Communication Equipment			
1. Air/ground receivers	7-12	3	2
2. Recorders	3	2	1
3. Power supply/distribution panel	2	1	
4. Resectoring panel	As required	1	
5. Main/standby relay panel	As required	1	
6. Miscellaneous equipment	As required	1	
7. Weather equipment	As required	1	
8. NAVAIDS /vis aids monitor racks	8	2	
9. Audio jack panels	3		
10. Position power supply	1		
11. Terminal racks	4		
12. Tone equipment racks	2		
13. Mixing amplifiers	1		
14. Voice switch	1	1	1
15. Voice switch maintenance position	1	1	1
B. Radar Equipment			
1. Radar			
a) ARTS II/III		1	
b) Numeric Generator Units		3	
c) Rack Line Compensator Trigger Dist. Unit		1	
d) ASDE Console	1		
e) ASDE PPI	1		
f) ASR-8/9 Com.	1		

EQUIPMENT	QUANTITY		
	MAJOR ACTIVITY	INTERMEDIATE ACTIVITY	LOW ACTIVITY
2. ARTS II/IIIE			
a) APC cabinet		1	
b) RADS display, maintenance (TRACON only)		1	
c) Dacom modem rack		1	
d) ASR-37		1	
e) Video mapper		1	
3. ARTS IIIA/IIIIE			
a) PEC cabinet (magnetic tape unit)	1		
b) IOP cabinet(s)	As required		
c) Dacom modem rack	1		
d) BRITE A/N	1		
e) BRITE	1		
f) Buffer	2		
g) ATCBI-3 Nom. Com.	3		
h) ATCBI-3 Com.	2		
i) Video Mapper	1		
j) Maintenance display (portable)	1		
k) FA-8762 Common equipment	1		
l) ASR-37/42	1		
m) Medium speed printer	1		
n) Disc drive	1		
o) RTCCS (FA-9485)	1		
C. Cab Equipment			
1. DBRITE			
a) Control panel	As required	As required	As required
b) Display	As required	As required	As required
2. Wind indicators	As required	As required	As required
3. DASI	As required	As required	As required
4. Digital time readout	As required	As required	As required
5. Field lighting panel	1-2	1-2	1
6. AWIS /electro-writer	1	1	1
7. FDIO			

EQUIPMENT	QUANTITY		
	MAJOR ACTIVITY	INTERMEDIATE ACTIVITY	LOW ACTIVITY
a) Keyboard/monitor	1	1	1
b) Printer	2	2	2
8. ATIS	1-2	1-2	1
9. ARTS keyboard	As required	As required	As required
10. Approach light system (ALS) control	As required	As required	As required
11. Voice switch common equipment			
a) Direct access	As required	As required	As required
b) Telephone jack	As required	As required	As required
c) Speaker module	As required	As required	As required
d) Radio select module	As required	As required	As required
e) TED keypad	As required	As required	As required
12. Convenience Unit	1	1	1
a) Compact refrigerator			
b) Sink unit			
c) Microwave oven *			
d) Coffee maker *			
e) Chilled water dispenser			
13. HVAC control	1	1	1
14. Light guns	2	2	2
15. NAVAIID monitor	As required	As required	As required
16. Door release			
a) Control	1	1	1
b) Speaker	1	1	1
17. Fire alarm	1	1	1
18. LLWAS display	As required	As required	As required
19. ASDE			
a) Cab unit	1	-	-
b) Display	As required	-	-
20. ILS/MLS monitor	As required	As required	As required

EQUIPMENT	QUANTITY		
	MAJOR ACTIVITY	INTERMEDIATE ACTIVITY	LOW ACTIVITY
21. Podium	As required	As required	As required
22. Strip bay	As required	As required	As required
23. Light dimmer switch	As required	As required	As required
24. Portable transceiver	As required	As required	As required
25. CONRAC monitors administration phone system FDEP	1	1	1
26. Telephone	1	1	1
27. PDC			
a) Monitor	1	-	-
b) Keyboard	1	-	-
28. Radar control	1	1	-
29. RVR/RVV control	As required	As required	As required
30. TMU workstation	As required	-	-
31. Engine generator (E/G) monitoring	1	1	1 (TRACAB)
D. TRACON Equipment			
1. ARTS display	As required	As required	-
2. FDIO			
a) Keyboard/monitor	As required	As required	-
3. ASR-37/TTY emulator	As required	As required	-
4. Wind indicator	As required	As required	-
5. DASI	As required	As required	-
6. Overhead control (1 for every 5 positions)	2-3	1-2	-
7. Beacon decoder	1	1	-
8. Digital Time Readout	As required	As required	-

EQUIPMENT	QUANTITY		
	MAJOR ACTIVITY	INTERMEDIATE ACTIVITY	LOW ACTIVITY
9. TMU workstation	As required	-	-
10. Voice switch common equipment			
a) Direct access	As required	As required	-
b) Telephone jack	As required	As required	-
c) Speaker module	As required	As required	-
d) Radio select module	As required	As required	-
e) TED keypad	As required	As required	-
11. Telephone	As required	As required	-
12. E/G and UPS monitoring	1	1	1 (TRACAB)
13. Door release			
a) Control	1	1	-
b) Speaker	1	1	-
14. ARTS panel	-	-	1 (TRACAB)

* Items C.12c and C.12d are not required to be physically attached to the convenience unit.

TABLE 2-4. TYPICAL POWER AND COOLING REQUIREMENTS FOR ARTS IIIA EQUIPMENT

EQUIPMENT	WATTS	BTU/HR
PCAB (populated)	3,847	15,390
1. IOPB	955	4,000
2. Memory 16K	850	3,400
3. CMA	240	960
4. RFDU	476	1,904
5. MDBM	600	2,400
6. BCAB	440	1,760
PEC (populated)	3,000	12,000
SRAP (dual)	2,000	8,000
DCU	337	1,200
DDU	1,520	7,000
IBAG	1,100	3,600
CMC	337	1,200

TABLE 2-5. TYPICAL SITE POWER AND COOLING REQUIREMENTS

EQUIPMENT	WATTS	BTU/HR
Single Beacon		
1. ARTS IIIA	25,000	97,200
Dual Beacon		
1. ARTS	6,800	27,390
2. STARS	See Table 2-6	See Table 2-6
3. EARTS	34,000	131,000
RCL/LDRCL		
1. RF rack	528 VA	1660
2. MUX (@2 channel banks)	432 VA	1358
RDVS IIA		
1. Equipment rack 1	2.1 KW	6600
2. Equipment rack 2	0.97 KW	3049
3. QCT	500 W	1572
FDIO		
1. PC-RCU rack	1.0 KW	3143
MDS (test outlet)	500 W	1572
BWM		
1. Rack 1	8.2 KW	25773
2. Workstation	1.8 KW	5657
DVRS2		
1. Recorder	400 W	1257
2. Reproducer	400 W	1257
VSBP (per UPS)	450 W	1414
PREMNET 5000		
1. Standard unit	540 W	1697
RCE		

EQUIPMENT	WATTS	BTU/HR
1. Control – RCE	25 W	79
CM-200 receivers	8 W	25
Multicouplers		
1. VHF (decibel prod)	15 W	47
2. UHF (decibel prod)	15 W	47
Coded time source		
1. Receiver	151 W	475
2. Distribution amplifier	65 W	204
DMN		
1. 3600 codex modem	80 W	251
2. EIA patch panel (CPP AR-4)	0.013 kVA	41
3. 2185 digital bridge	10 W	31
4. Hadax digital bridge	10 W	31
Fiber optic DBRITE hub	TBD	
ETMS		
1. Data router	100 W	314
2. Workstation	500 W	1572
ACE-IDS		
1. ACC cabinet	1.8 kVA	5657
2. Workstation	720 VA	2263
3. Monitors (20")	85 W	267
TDWR		
1. MDT (remote)	500 W	1572
ITWS		
1. ITWS processor	6.24 kVA	19612
2. Communications rack	1.84 kVA	5783
DASI		
1. Sensor translator	60 W	189

EQUIPMENT	WATTS	BTU/HR
2. Display unit	10 W	31
3. Decoder unit	10 W	31
Remote monitor and control		
1. ASR-8 workstation	500 W	1572
2. ARSR-4 workstation	500 W	1572
3. Mode S workstation	500 W	1572
Remote monitor and control		
1. CMS workstation	500 W	1572
ARMS (Airport RMS)		
1. Link control unit (LCU) (Unit 1)		
2. Power supply (Unit 4)	224 W	704
VOT		
1. Monitor/transmitter	500 W	1572
SSRBDS		
1. Decoder power supply	N/A	
2. Radar beacon monitor	N/A	
3. SS beacon decoder	300 W	943
Dantel (IWA ASR-8)	300 W	943
Dual remote SCIP		
1. Unit 24)	7000 W	22001
Remote data communications		
1. Unit 21/23	1000 W	3143
ASR-9 SCIP		
1. Unit 24	7000 W	22001
Remote data communication equipment		
1. Unit 21/23	1000 W	3143
ARMS (Airport RMS)	500 W	1572
Administration LAN system	TBD	
Network system		

EQUIPMENT	WATTS	BTU/HR
1. CBI workstation	500 W	1572
TDLS D-ATIS		
1. TDLS power usage	502W	1578
LLWAS/CFW		
1. Processor/monitor unit	500W	1572
RRCS	500W	1572
ILS		
1. Power supply unit 4	224W	704
RVR		
1. DPU	460W	1446
ASDE-X		
1. SMR pedestal (ATCT roof)	4000 W	12572
2. Display monitor (ATCT cab)	200W	629
3. Display/monitor processor	712 W	2238
4. SMR motor controller	3200W	10058
5. SMR dehydrator/compressor	170 W	534
6. SMR transceiver cabinet	3100W	9743
7. SMR power and monitor cabinet	6400W	20115
8. SMR data processor	2500W	7858
9. Processor cabinet	3500W	11001
10. Communication cabinet	500W	1572
11. RMS cabinet	280W	800

TABLE 2-6. STARS POWER AND COOLING REQUIREMENTS

EQUIPMENT	WATTS	BTU/HR
Terminal controller workstation (TCW)	1095	3442
Monitor controller workstation (MCW) (w/printer)	1829	5749

EQUIPMENT	WATTS	BTU/HR
GPW pseudo pilot	338	1062
Full service rack (FSR) (1-3R)	1899	5969
Emergency service rack (ESR) (1-3R)	1907	5994
TCW hub rack (12-35 TCW)	897	2819
Supplemental display	81	255
Communications rack	672	2112
Simulator	338	1062
Site support server	338	1062
CSU/DSU (nominal)	15	47

36. SPECIALIZED ENVIRONMENTAL FACTORS.

a. Much of the equipment installed in ATCTs has special environmental requirements that will affect the facility design. These environmental requirements are a function of space relationships and equipment operating parameters. For example, certain ATCT complex area-critical functions will necessitate special consideration that includes redundant heating, ventilation, and air conditioning (HVAC) systems.

b. Environmental control and monitoring systems (ECMS/DDCS) used for building management monitoring and control shall be installed at all intermediate and major activity facilities.

1) These systems shall be automated and shall provide performance monitoring, status, control, alarms, and energy management.

2) Refer to FAA-STD-033), Energy Management in NAS Physical Facilities, paragraph 242.k for all major building mechanical/electrical systems/subsystems.

3) These systems shall be an open system design that does not rely on a specific manufacturer's proprietary hardware or software.

37. OTHER SPACE REQUIREMENTS.

a. Several military and civilian agencies have agreements with the FAA for the operation of equipment and lease of space at certain ATCT/TRACON facilities.

b. Several telephone companies (telcos) also provide and maintain equipment located at FAA facilities, and a provision should be made for separate telco room access.

c. Telco equipment will be installed in an area to which telco employees have access in accordance with facility security requirements but that does not allow them access to the remainder of the facility. This allows the telco to maintain their equipment without an FAA escort or having access to the operating facility. These agreements may increase space requirements and should be reviewed in the initial stages of the design process.

d. The designer shall plan hazardous or flammable material storage required for daily and ongoing operations.

e. Security requirements are addressed in paragraphs 24, 79, and 302.

38. SPECIAL ATCT/TRACON CLASSIFICATIONS. The designer should remain flexible and address any special requirements, as defined by the designated approval authority, peculiar to the airport activity classification for a specific location. The design classifications listed in Table 2-2 are intended to be nominal only. However, the general design elements do not always determine a particular design classification.

38-1. FAA CONTRACT TOWER (FCT) EQUIPMENT. Table 2-7 lists the FCT minimum operational equipment. This list is applicable to locations where the Airport Sponsor provides and maintains air traffic control (ATC) operational equipment. The equipment shall be furnished and maintained in accordance with applicable FAA standards and regulations. These standards and regulations include, but are not limited to, the FAA Orders identified in Appendix 1.

TABLE 2-7. FAA CONTRACT TOWER EQUIPMENT

FCT Equipment
<p>1. Voice switch communication equipment capable of radio and telephone ATC communication, as appropriate. This shall include the capability of headset use and instructor/student override capabilities.</p>
<p>2. One headset per controller and one handset per position, with appropriate spares.</p>
<p>3. Very High Frequency radios for ground/air communication, as required, to support level of traffic; i.e., Local Control, Ground Control, Automated Terminal Information Service, Clearance Delivery, and Emergency. One transmitter and one receiver for each frequency. Handheld radios are not authorized as primary units.</p>
<p>4. Ultra High Frequency radios for ground/air communication, as required, to support military operations. Handheld radios are not authorized as primary units.</p>
<p>5. Landline communication system with direct access line to controlling instrument flight rules facility.</p>
<p>6. Tunable emergency back-up transceiver with battery back-up supply.</p>
<p>7. Dual deck, multi-channel, voice recorder system for continuous unattended recording of each position used for receiving/transmitting ATC clearances, coordination, and instructions. Capabilities must include: synchronized recording of time, playback without recording interruption, re-recording to suitable portable storage media and/or a portable recorder with re-recording capability, any internal storage media must be configurable to preclude retention of data older than 15 days, and remote alarm. Appropriate storage media must be provided (one for each of 15 days, plus spares).</p>
<p>8. Back-up power source for essential equipment, (i.e. radios, voice switch), cab</p>

FCT Equipment

HVAC, etc.

9. Two altimeter setting indicators. A certifiable digital altimeter setting indicator (DASI) is preferred and required if ASOS/AWOS or a “traceable pressure standard” is not available within ten miles for precision approaches and 25 miles for non-precision approaches (FAA Order 7210.3, Section 8 and FAA Notice 7210.477). Aircraft altimeters are not acceptable.

10. Two direct reading wind indicators.

11. If ASOS/AWOS is available on the airport, locate ASOS/AWOS Operator Input Device (OID) in the tower cab. If tower is ATIS equipped, provide an ASOS/ATIS interface device.

12. Two pair of operable binoculars, 7x50 or greater.

13. Signal lightgun with a back-up power source.

14. At least one 24-hour clock with seconds display; i.e., digital LED.

15. Alert system to notify airport emergency equipment operator.

16. Airport lighting controls.

17. Window shades as prescribed in FAA regulations for all tower cab windows (adjustable). (FAA specification E 2470.)

18. Mechanical or electronic traffic counting device.

19. Position lighting (to support established operating positions with rheostat control).

20. Electrostatic Discharge (ESD) resistant controller chairs of appropriate height for the conduct of tower operational duties.

21. Floor covering shall be ESD resistant.

22. Note for 20 and 21: other floor grounding apparatus may be necessary dependant upon specifications of the electronic equipment installed.

23. Administrative telephone with handsets in the operating and administrative quarters.

24. Appropriate non-operational space and equipment will also be provided. This must include:

- Lockable Air Traffic Manager’s office
- Restroom one floor below the tower cab

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FCT Equipment
<ul style="list-style-type: none">• Training/break room• Appropriate desk, chairs, table, locking file cabinet

CHAPTER 3. REPRESENTATIVE AIRPORT TRAFFIC CONTROL TOWERS AND TERMINAL RADAR APPROACH CONTROL FACILITIES

SECTION 1. BASIC COMPONENTS

39. INTRODUCTION. ATCT/TRACON facilities have three basic components: control cab or cab, tower shaft or shaft, and base building. Each basic component is defined in Appendix 2, and the following three paragraphs discuss the function of each.

40. CONTROL CAB. The cab is the primary control tower operating space. The cab shall be situated at the desired elevation above ground level (AGL) and physically oriented relative to the primary runways to provide the best unobstructed view of the airport aircraft primary movement areas (taxiways and runways).

41. TOWER SHAFT. The primary tower shaft function is to support the raised cab at the desired elevation. Tower cab access can be provided with a stairway and/or elevator. Tower shafts can be structurally independent (freestanding) or an integral part of another related structure such as a terminal building or base building.

42. BASE BUILDING. The base building is a single or multiple-story building adjacent to the tower shaft. Its primary function is to provide facility functional space. When the base building is structurally independent, it is usually attached to the tower shaft with an access corridor or link. The base building is normally used to house the equipment necessary to support the operational needs of the ATCT and TRACON, including space for administrative and training functions.

SECTION 2. BASIC CONFIGURATION

43. INTRODUCTION. The three basic components of an ATCT/TRACON can be combined in a limited number of ways to design a facility. The preferred design is a non-functional tower shaft supporting the control cab and a base building.

44. BASE BUILDING AND NON-FUNCTIONAL SHAFT. The basic configuration is a cab on a shaft with a base building.

a. The shaft is not utilized for functional space except for minimal mechanical and electronic equipment located directly below the cab. The shaft provides cable routing to the tower cab. Support personnel shall not be housed in the shaft. The base building and non-functional tower shaft offers the following attributes:

- 1) Flexibility in space arrangement.

- 2) Potential for future expansion.
- 3) HVAC units may be located on the base building roof, thereby alleviating potentially crowded conditions of interior mechanical spaces.
- 4) A base building lends itself to more convenient, safe, and efficient circulation of people.
- 5) ATCTs and TRACONs may be independently constructed and remotely located for economy and land acquisition ease.
- 6) Standardization of a non-functional tower shaft with support spaces in a base building can significantly reduce design and construction costs; because functional floor space in elevated, shaft levels are very expensive.

45. FLEXIBILITY OF THE BASIC CONFIGURATION. The basic configuration flexibility is limited because of certain specific requirements, such as accessibility and space relationships imposed by equipment and personnel. The personnel and functional space arrangement required for efficient facility operation places restrictions on the designer. Furthermore, established policy directives regarding ATCT/TRACON facilities will set prescribed design limitations.

46. VARIATIONS OF THE BASIC CONFIGURATION.

- a. Although the basic configuration described above may seem to restrict the ATCT/TRACON facilities design, configuration variations are allowed.
- b. Figure 3-1 through 3-4 illustrate ATCT/TRACON designs currently in use that represent the basic configuration.
- c. The designer should be aware of the flexibility of the basic configuration and not limit conceptual planning to these or any other examples unless specifically directed.

47. - 49. RESERVED.



**NON-FUNCTIONAL SHAFT WITH 6,200 SF TRACON BASE BUILDING –
INTERMEDIATE ACTIVITY**



**NON-FUNCTIONAL SHAFT WITH 8,400 SF TRACON BASE BUILDING –
INTERMEDIATE ACTIVITY**

FIGURE 3-1 REPRESENTATIVE AIRPORT TRAFFIC CONTROL FACILITIES



**ADMINISTRATIVE BASE BUILDING AND NON-FUNCTIONAL SHAFT
INTERMEDIATE ACTIVITY**



**ADMINISTRATIVE BASE BUILDING AND NON-FUNCTIONAL SHAFT MAJOR
ACTIVITY**

FIGURE 3-2 REPRESENTATIVE AIRPORT TRAFFIC CONTROL FACILITIES



24,000 SF TRACON BASE BUILDING AND NON-FUNCTIONAL SHAFT MAJOR ACTIVITY



14,500 SF TRACON BASE BUILDING AND NON-FUNCTIONAL SHAFT MAJOR ACTIVITY

FIGURE 3-3 REPRESENTATIVE AIRPORT TRAFFIC CONTROL FACILITIES

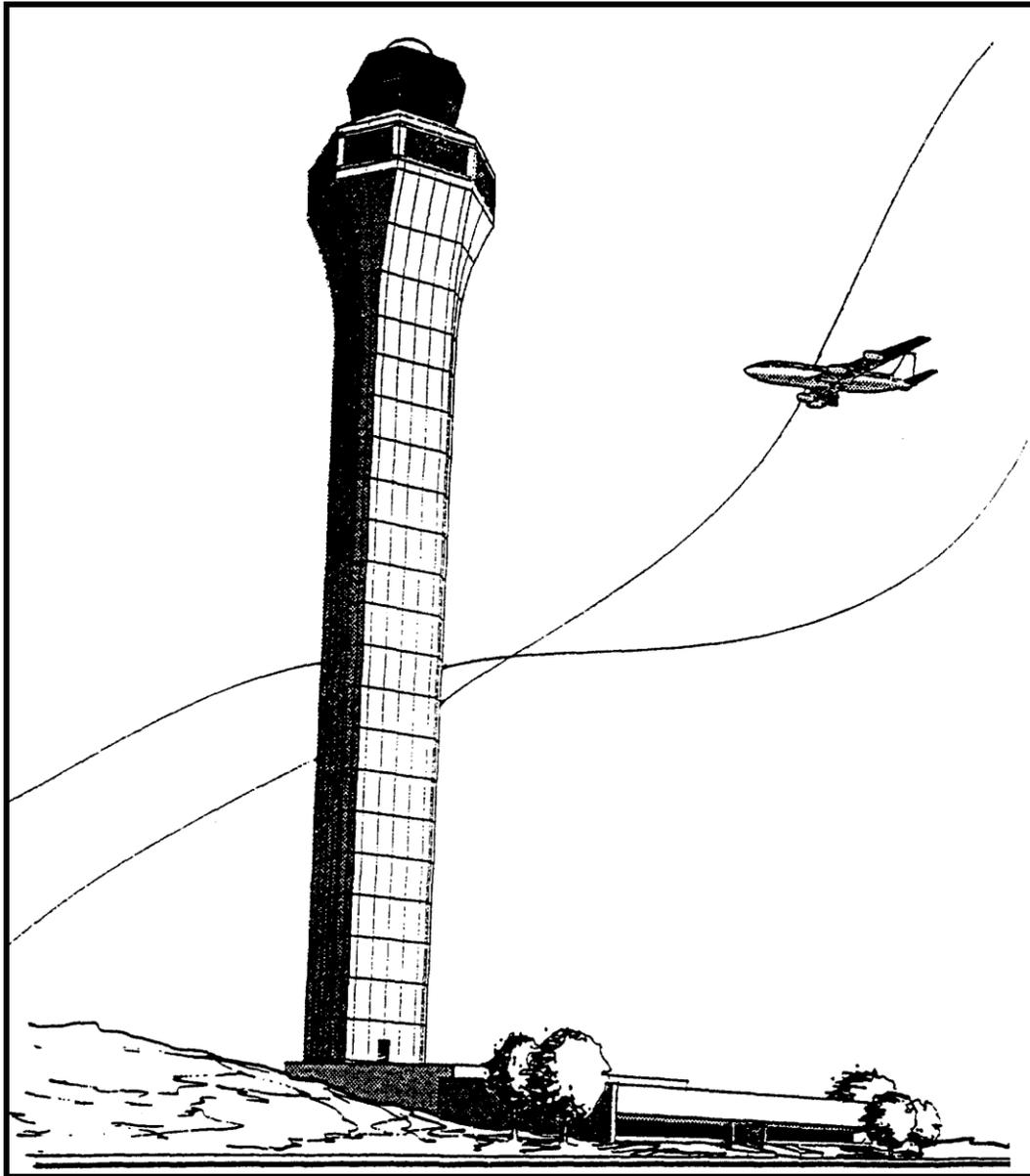


FIGURE 3-4 REPRESENTATIVE AIRPORT TRAFFIC CONTROL FACILITIES

SECTION 3. REPRESENTATIVE SITE LAYOUTS

50. INTRODUCTION. Several factors influence the site layout and design for ATCT/TRACON facilities. Although many of these factors cannot be established prior to site selection, certain basic parameters such as activity level, ATCT design classification, security, budget limitations, staffing, utility requirements, parking requirements, etc., can be predetermined. An overview of

the differences normally associated with design classification is provided in this chapter as an aid in achieving better initial specific project scope understanding. See paragraphs 24, 79, and 302 for security requirements.

51. COMPARATIVE EXAMPLES. The tremendous site layout diversity at existing ATCT/TRACON facilities with the same activity level is an indication that many variables control site design. Still, some basic standards can be identified in almost every site developed. It is important for a designer to recognize the relationship of general site requirements to the different activity levels. For this reason, Appendix 3 Representative Space Layouts and Console Drawings Figures 1 through 3 illustrate existing sites for each level of activity. These drawings are included as representative examples only and are not intended to establish any specific design criteria.

52. - 53. RESERVED.

SECTION 4. REPRESENTATIVE TECHNICAL AND OPERATIONAL SPACE LAYOUTS

54. DESCRIPTION. Appendix 3 Representative Space Layouts and Console Drawings, Figures 4 through 15, contain layout drawings that exhibit representative technical and operational space variations that include cab, TRACON, communication, and radar areas. These drawings are included as representative examples only and are not intended to establish any specific design criteria. The dimensions on these drawings are recommended; however, actual dimensions shall be based on the consideration of pullback/pullout clearances for equipment maintenance/replacement, peak personnel traffic (shift change), and minimizing noise (voice) interference from other positions.

55. - 58. RESERVED

CHAPTER 4. SITE SELECTION AND DESIGN

SECTION 1. INTRODUCTION

59. GENERAL.

a. This chapter provides objectives, influencing factors, and requirements affecting ATCT/TRACON facility site design. The major consideration in ATCT cab design, orientation, construction, and location within the airport facility is air traffic controller visibility. The ATCT may be located on a site near the terminal, across the airfield opposite the terminal, or integrated into the terminal. An ideal location is one that allows total unrestricted visual contact with all types of traffic on and around the airport. Due to other structures on the airport, the controller's line-of-sight will normally be obstructed unless the controller is near the runway and high above the ground.

b. Safety criteria in FAR Part 77 limit the tower height and require that it be located well away from the runway centerline. It also shall not interfere with terminal procedures such as missed approach paths.

c. Sites in or near the terminal area are not always the most desirable, as they add complexities to site considerations. These sites will have several restrictions of one type or another. As a rule, these sites are relatively small, odd shaped, obstructed, and congested or any combination of these factors.

d. Site design criteria required in this chapter, where applicable, shall apply to each ATCT and TRACON site regardless of location, configuration, or category. TRACON sites are less restrained by airport configuration but are usually co-located with the ATCT. Locating the ATCT or TRACON near the airport surveillance radar (ASR) is not necessary with digital format radars.

60. GUIDELINES. The minimum ATCT and TRACON site standards and requirements are chronologically presented in three major categories: (1) site selection, (2) site investigation, and (3) site design. Each of these sections involves criteria that shall be met before work can proceed on subsequent design phases.

SECTION 2. SITE SELECTION

61. PRELIMINARY CONSIDERATIONS. Site selection activities are initiated after it has been determined that an airport qualifies for a control tower or that an existing control tower facility is inadequate and requires relocation or replacement. Site selection may be predetermined by the airport master plan or airport layout plan. In any event, the site selection process requires analysis of factors that include the following:

- a. Economics.

1) Utilities shall be evaluated for availability, future expansion capability, and accessibility to assure that excessive cost will not be incurred because of the site condition and/or location.

2) Site preparatory work cost assessment should be made for the same reason. Preparatory work includes all work required on topography, ground water condition, environmental clean-up, soil stability and geology, and drainage to adapt the site for construction and/or use.

3) In addition, the site-required tower height must be calculated because project costs increase significantly and proportionally with tower height.

b. Visibility.

1) Refer to Order 6480.4, Airport Traffic Control Tower Siting Criteria, to review visibility requirements.

2) Complete airport surface area visibility shall be assured at all times of day. This includes movement in controlled air traffic related surfaces.

3) Tower cab orientation shall minimize major airport activity point obstruction. Maximum airborne traffic pattern visibility, unobstructed direct runway approach path, and landing area viewing are essential.

4) Visibility shall not be impaired by direct or indirect external light sources. Such sources may be ramp lights, parking area lights, a rising or setting sun, and reflective surfaces.

5) Local weather phenomena shall be given consideration to preclude visibility restriction caused by fog or ground haze.

c. Land Area Requirements.

1) A guide to lot size is shown in Table 4-1.

2) Site land requirements shall be coordinated in accordance with FAA Order 1600.69, paragraph 304, Appendix 9.

3) Site size includes that land required for structures, sidewalks, docks, areas between tower and other structures, and base building future expansion requirements.

4) Adjacent airport development and lot shape will also affect lot size.

5) See paragraphs 24 and 79 for additional security requirements.

d. Parking Requirements. While it is desirable to have FAA employee parking adjacent to the ATCT complex, employee parking may be provided by the airport and may be located away from the tower. Areas in addition to that recommended in Table 4-1, may be required where odd shaped parcels are involved.

e. Environmental Due Diligence Audit (EDDA). The EDDA shall be completed in accordance with FAA Order 1050.19), Environmental Due Diligence Audits in the Conduct of FAA Real Property Transactions.

f. Security. A security assessment shall be completed to determine building setback requirements.

g. Compatibility. Other airport facilities, existing or proposed, shall be examined to determine their compatibility with the ATCT. Conditions that adversely affect operations, such as structures restricting view or conditions that adversely impact the use of equipment; i.e., potential sources of radio frequency interference (RFI) or electromagnetic interference (EMI) and microwave and equipment telemetry link line-of-sight, should be avoided.

h. Maintainability and Accessibility. Consideration should be given to maintainability and accessibility requirements. The site shall be able to accommodate equipment that may be required to support site maintenance efforts.

TABLE 4-1. AREA REQUIREMENTS

Facility Type	Site Area	Parking		Perimeter & Future Site Expansion	Total
		Spaces	Area		
Low Activity ATCT	4,800 SF	10-40	2,700 SF to 10,800 SF	Up to 10,000 SF	10,200 SF to 25,000 SF
Intermediate Activity TRACON	14,400 SF	30-80	8,100 SF to 21,600 SF	Up to 20,000 SF	25,000 SF to 56,000 SF
Intermediate to High Activity ATCT	18,000 SF to 22,500 SF	40-60	10,800 SF to 16,200 SF	Up to 20,000 SF	25,000 SF to 58,000 SF
Intermediate Activity ATCT/TRACON	(ARTS II) 22,500 SF	60-100	16,200 SF to 27,000 SF	Up to 20,000 SF	40,000 SF to 70,000 SF
Major Activity TRACON	30,000 SF	60-130	16,200 SF to 35,100 SF	Up to 30,000 SF	48,000 SF to 95,000 SF
Major Activity ATCT/TRACON	40,000 SF to 52,000 SF	80-200	21,600 SF to 53,000 SF	Up to 30,000 SF	62,000 SF to 135,500 SF

62. SITING CRITERIA. The required ATCT siting criteria and minimum eye level determinations are outlined in FAA Order 6480.4.

63. APPROVAL. A layout plan indicating the approximate site size, tower location and other structures, access roads, and parking accommodations should be submitted to the designated approval authority for approval. The designated design approval authority is defined as the first level supervisor for the specific tower project design engineer. Deviations are approved in accordance with paragraph 22.

SECTION 3. SITE INVESTIGATION

64. GENERAL. Site investigation will require proposed project site visitation to become familiar with the site and surrounding environments prior to starting the design and document preparation. Information on utility services available in the site vicinity should be collected early and verified during a site visitation.

65. BOUNDARY SURVEY. A boundary survey shall be made to establish the site limits. These limits shall be marked at corners or directional changes on the perimeter with permanent monuments. The survey shall include a drawing prepared at a scale suitable for clarity,

graphically representing the survey. The boundary survey should be performed concurrent with and by the same registered surveyor performing the topographical survey.

66. TOPOGRAPHIC SURVEY. A topographic survey shall be conducted and shall graphically represent the site, including location of existing structures, utilities, cables, etc., and the extent of trees and vegetation on the site.

- 1) The survey shall also provide one (1) foot contours at a clear suitable scale.
- 2) It shall include an area outside the limits of the site boundary sufficient to provide the designer with enough information to blend the site grading into the surrounding terrain.
- 3) A temporary benchmark, produced from a permanent benchmark on the airport, shall be established at a close proximity to the proposed building site.
- 4) All elevations shall be expressed from mean sea level (MSL).
- 5) The survey shall be prepared in electronic media/format and shall be compatible with existing FAA electronic resources as defined by the designated approval authority.
- 6) Registered surveyor seals shall be prepared in accordance with local and state requirements.
- 7) A brief report shall be prepared to document the utility availability, as well as rough order of magnitude connection costs or extending the utilities to the proposed site.

67. SOIL AND FOUNDATION ANALYSIS. Soil and foundation conditions shall be investigated to assure that the proposed structure and foundation suitability does not require extraordinary soil preparation effort.

a. A soil investigation to determine type and condition of soil is required. An analysis and engineering report is required in accordance with paragraph 207.

b. General report requirements include foundations, structures, pavement, excavated soil reuse as backfill, and site development recommendations.

c. Investigation Information. The required investigation information that is not limited to, but shall include preliminary data for:

- 1) Structures.
- 2) Location, size, and construction type.
- 3) Perimeter grade beam loading.
- 4) Interior and exterior column loading.
- 5) Structural slab loading.

- a) Wind shear.
- b) Wind overturning moment.
- c) Weather.
- 6) Pavement.
 - a) Location.
 - b) Loading.
 - c) Traffic requirements.
 - d) Accessibility.
 - e) Water runoff impact.
- 7) Site Development.
 - a) Proposed area of construction.
 - b) Location of proposed utilities.
 - c) Drainage considerations.
 - d) Erosion control measures.

d. Report Requirements. The general requirements of the engineering report shall not be limited to, but shall include recommendations for:

- 1) Structures.
 - a) Foundation Element. This shall include detailed design criteria for the foundation(s) type or types recommended.
 - b) Soil settlement characteristics.
 - c) Detailed specification preparation criteria, including information on excavation, dewatering, or special specific problem area consideration types.
- 2) Pavements.
 - a) Soil suitability, removing and replacing necessity, and acceptable material availability.
 - b) Compaction properties.
 - c) Proposed site-suitable pavement type, rigid or flexible, recommendation.

- 3) Site Development.
 - a) Type of materials to be encountered in excavation on the site.
 - b) Unusual drainage. Conditions on or adjacent to the site.
 - c) Soil problems that involve significant properties that could affect design.
 - d) Equipment access to and mobility on the site.

68. UTILITIES. Determining which utilities are to be utilized requires consideration of several factors: availability, nearest source, service quality, energy conservation incentive program, and local restrictions or requirements. Consultation with each utility and the airport sponsor to determine the responsibility for extending the service to the site, connections, demand requirements, and procedures will be required.

69. HAZARDOUS MATERIAL SITE SURVEY. A site survey shall be conducted that includes soil and foundation analyses to determine if any pre-existing contamination from hazardous materials waste is present that could affect the facility design or personnel safety or health. Refer to paragraph 61.e concerning EDDA.

70. HAZARDOUS MATERIALS. Hazardous material shall be identified, monitored, and managed in accordance with national, state, and local environmental regulations.

71. - 72. RESERVED.

SECTION 4. SITE DESIGN

73. EARTHWORK AND SITE PREPARATION. The geotechnical recommendations report required in Section 3 will provide characteristics, composition, and properties of the soil.

a. Consideration of clearing and grubbing, normally the initial phase, requires investigation of several items, including borrow and waste areas, the protection of existing utilities, erosion and dust control, and provisions for hazardous and objectionable material disposal.

b. Grading. Limits, acceptable tolerances, and adequate explanation provided through plans and specifications are necessary to successfully prepare the required design.

74. STORM DRAINAGE. FAA Advisory Circular 150/5320-5, Airport Drainage, together with federal, state, and local regulations, shall be used during the design of site drainage systems.

a. Unusual drainage conditions on or adjacent to the site shall be considered, including rainwater effluent drainage effects.

b. The maximum rainfall intensity-frequency criteria should be based on the maximum one-hour rainfall, in inches, to be expected once in 50 years.

c. The designer shall review the airport storm sewer drainage system to ensure localized flooding runoff or airport ponding will not affect the site.

75. ACCESS ROADS. Roads or streets providing access to the ATCT/TRACON site shall be designed to conform to the American Association of State Highway Transportation Officials (AASHTO) guidelines and other state and local requirements. Consideration shall be given to future maintainability, such as using interlocking pavers in areas where appropriate.

a. Layout. Access to the site shall provide for the shortest and most direct routes that will not be affected by traffic interruption, such as rail crossings, major traffic routes, or aircraft movement. Streets on the site shall be designed to provide access with the least traffic congestion. Layout plans shall include existing and final contours, centerline profile, and shall be supplemented by adequate typical sections representative of the various conditions.

b. Grade.

1) In areas subject to snow and ice conditions, longitudinal grade should not exceed 5 percent.

2) In all other areas, grade may be increased to 6 percent maximum.

3) Transverse grades shall not exceed 2 percent.

c. Width.

1) Lane width should be ten (10) feet excluding curb and gutter.

2) Intermediate and major activity facilities should have a two-lane access road.

d. Shoulders.

1) Minimum shoulder width shall be not less than three (3) feet.

2) Where shoulders slope to the street, the maximum slope shall be 2 percent.

3) Where the shoulder slopes away from the street, the minimum slope shall be 3 percent.

e. Curb or Curb and Gutter.

1) Curb or curb and gutter is recommended for all flexible pavement.

2) Where rigid pavement is specified, curb or curb and gutter may be provided as required by design.

f. Pavement Design. Several designs are generally possible for a specific site. The most practical and economical design is normally selected. Since the decision on the practicability of a particular design may be largely a matter of judgment and site location, full particulars regarding

the selection of final design, including the recommendations provided in the soils report, shall be included in the design analysis. All materials and construction procedures shall conform to the state highway specifications for the state in which the project is to be constructed.

g. Fire Department Access. The building access roads shall accommodate fire department apparatus access to buildings consistent with the applicable model building code.

h. Fire prevention requirements.

1) Minimum access road requirements are: an all-weather paved surface with not less than 20 feet unobstructed width, adequate roadway turning radius, shall support heavy fire apparatus, and provide a 13 feet, 6 inch minimum vertical clearance.

2) Access roadways should also be constructed with parking outside the unobstructed width requirements.

3) The roadway limits should facilitate the fire department suppression and rescue operations, including tower aerial ladder operations.

4) Verify any local jurisdiction requirements that may exceed model code requirements.

76. PARKING ACCOMMODATIONS. The parking lot size shall accommodate the peak demand that occurs during shift changes. FAA Order 4665.3, Policy on Parking Accommodations at FAA Occupied Buildings and Facilities, FED-STD-795, FAA Order 4660.1, Real Property Handbook, and AMS policy (with FAA Order 4420.4, Space Acquisition as a historical background document), contain criteria for employee parking, visitor parking, disabled parking, material deliveries, and official parking recommendations. The parking lot shall include motorcycle parking provisions on a concrete pad. Additional requirements include:

a. Layout.

b. Figure 4-1 shows some typical parking lot configurations. Raised curbs, bumper islands, and wheel stops should not be incorporated within interior parking areas and certain perimeter areas at locations where snow removal operations will be conducted.

c. Grade. Minimum slope shall be 1 percent. Maximum slope in areas subject to ice and snow conditions shall be 3 percent longitudinal and 3 percent transverse.

d. Pavement Design. Parking lot pavement design, curb or curb and gutter, materials, and construction procedures shall conform to the requirements outlined in paragraph 75, Access Roads.

e. Parking Traffic Control Signs. Parking traffic control signs should be provided within the parking area limits indicating parking, no parking, exit, do not enter, disabled persons parking, stop, speed limit, etc., as appropriate. Signs should be furnished and installed in accordance with U.S. DoT publication, Graphic Standards for the U.S. Department of Transportation, FAA Order 1730.8, FAA Graphic Standards, and FED-STD-795. Traffic control signs shall be purchased in accordance with Environmental Protection Agency (EPA) Comprehensive Procurement

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Guidelines (CPG) program under the Resource Conservation and Recovery Act (RCRA) procurement requirements. Information is available at the EPA web site (<http://www.epa.gov>).

f. Engine Block Heater Outlets.

1) Vehicle engine block heater weatherproof outlets shall have ground fault interruption protection and should be installed in parking areas reserved for government/maintenance vehicles where severe winter conditions exist.

2) Additionally, engine block heater outlets may be required at employee parking spaces at locations where there is an agreement with employees to do so.

3) Engine block heater outlets are to be installed for sites having an exterior design temperature of zero degrees F or less. In accordance with ASHRAE Handbook, Fundamentals, Table 1A, Heating and Wind Design Conditions – United States, use the 99 percent heating DB data for the nearest station to the site.

g. Parking Lot Visibility. There should be an unobstructed view of access roadways when exiting facility parking lots.

h. Security Requirements. Refer to paragraphs 24, 79, and 302 for parking security reference documents.

77. SIDEWALKS. Concrete sidewalks shall be provided in accordance with operational and pedestrian traffic requirements and shall conform to disabled access requirements mandated by federal regulations.

- a. Minimum clear width of the sidewalk shall be four (4) feet.
- b. The sidewalk shall conform to the finished grade, with maximum 1/4 inch per foot cross-slope in the direction of natural drainage.
- c. Interlocking pavers may be used for sidewalks where appropriate.
- d. Sidewalks shall meet FED-STD-795 requirements.

78. LANDSCAPING. Landscaping should be of a minimum maintenance design.

- a. A “xeriscape” design concept should be used, unless limited by local landscape building exterior requirements, such as use of plants from the local area.
- b. Plant specimens proven to be locally hardy and tolerant to specific site conditions shall be utilized.
- c. The location and tree species to be planted shall be such as to preclude roots from damaging underground facilities.
- d. Trees and shrubs shall be planted in such a manner as to provide minimum obstacles to efficient grass mowing and snow removal.
- e. Avoid plantings especially attractive to birds and animals.
- f. Sprinkler systems and hose bibbs shall be installed in those areas requiring irrigation.
- g. The landscape planting objectives are:
 - 1) Enhance exteriors and integrate the buildings with the adjacent open areas.
 - 2) Give scale and character to the buildings and their surroundings.
 - 3) Provide shade and wind breaks or snow breaks.
 - 4) Screen out views of less desirable features.
 - 5) Reduce noise, dust, and erosion.
 - 6) Minimize maintenance requirements, such as use of grass or ground cover that does not need to be mowed.
 - 7) Low maintenance, including minimization of fertilizers, herbicides, and watering required.

79. SECURITY. Federal Aviation Regulations, Part 107, Airport Security, provides requirements to prevent unauthorized airport operation areas access. The ATCT/TRACON is generally located within the airport security limits and would not necessitate additional security precautions. Lighting levels in parking areas shall provide employee safety and security. However, in the event that the facility was not included within the airport security system or airport security was breached in establishing the facility, FAA Order 1600.6, Physical Security Management Program, contains general guidance to secure the facility. For additional security requirements refer to paragraphs 24 and 302.

80. TRAFFIC SIGNS. Roadway signs, markings and traffic control should follow Order 1730.8, FAA Graphic Standards and DoT Manual, Uniform Traffic Control Devices for Streets and Highways requirements.

81. FACILITY SIGN. A facility identification sign shall identify each ATCT/TRACON facility. This sign shall be installed and conform to the current codes and FAA standards.

82. UTILITY SITE WORK. All utilities shall be protected by underground installation, marked for recognition, and readily accessible for maintenance. Layout or location of services shall take into consideration future expansion of the facility and/or additional demands that may be required of the service.

83. ACCESSIBILITY. Site design and development shall include requirements for accessibility to all spaces and shall conform to disabled access requirements mandated by federal regulations. Facility accessibility shall meet FED-STD-795, Uniform Federal Accessibility Standards (UFAS), requirements.

84. TRASH STORAGE AND DISPOSAL AREA. A trash and recycling dumpster concrete pad with concrete ramp shall be provided and should be located approximately 100 feet (25M) from the ATCT/TRACON building.

- a. See paragraph 302 for dumpster location security requirements.
- b. Dumpsters shall not be located near building air intake vents.

85. GEOLOGICAL SURVEY. A geological survey shall be conducted to determine local conditions that may affect building designs. A report shall be prepared outlining local geological conditions found, if any, and design considerations that shall be used in the building design.

86. - 88. RESERVED.

CHAPTER 5. ARCHITECTURAL DESIGN

SECTION 1. INTRODUCTION

89. GENERAL.

a. This chapter presents the ATCT/TRACON facility architectural design requirements. These requirements shall be closely coordinated with the other chapters in this order. The information contained herein gives a basis for materials selection and achieving uniform ATCT/TRACON facility construction. The base building and TRACON use is classified IBC Group B, paragraph 304.1.

b. This order cannot adequately cover all conditions for a nationwide construction program. The designer shall work with the applicable designated approval authority to obtain complete requirements where the criteria and standards are not given herein. The building and appurtenance's, except the tower cab, architectural design shall meet FED-STD-795. Applicable codes covering tower design include those noted in paragraphs 21 and 29, CFR 1960.20.

90. DESIGN CRITERIA.

a. Aesthetics. New structures need not conform to the established architectural style of the existing airports but should be harmonious and aesthetically pleasing. The structural, electrical, and mechanical components must be coordinated to achieve a facility that meets the operational criteria and requirements set forth by the FAA for that facility. The interior and exterior design should be functional.

1) Proper design requires attention to architectural detail and a concern for achieving an aesthetic solution to the problem while integrating the overall design of the facility with its functional requirements.

2) An important aesthetic consideration is the inherent monumental nature of the ATCT shaft that will establish the structure as a dominant feature of the airport complex and, as such, may serve as the architectural symbol for the airport. The representative examples in CHAPTER 1 are intended to be architecturally harmonious and compatible with the airport.

3) Local airport authorities typically fund significantly different designs from the representative example designs. All designs shall be coordinated with local airport authorities. While achieving aesthetic harmony, special attention shall be given to paragraph 90b.

b. Economics. The architectural layout should be based on the actual requirements set forth for the project, plus ten years minimum projected requirements following the commissioning date, based on FAA-approved terminal area forecasts and other studies. The design should incorporate the materials type, details, and construction methods that are suitable and appropriate when used in a building intended to serve a specific purpose with normal maintenance.

1) Economical basic design concepts shall be used rather than introducing extraneous and superficial features that are costly to produce and maintain.

2) For economy, the floor-to-floor or floor-to-roof heights shall be the minimum dimension possible consistent with construction contingencies, electronic equipment cooling, and easy access to cable trays.

a) The construction contingencies include depth of structural beams, mechanical equipment, electrical equipment, and operational equipment.

b) When feasible for single-story design, special ceiling height elements should be grouped under a single raised roof area.

3) Construction specifications shall be prepared in accordance with FAA-STD-005. Materials shall consider building life-cycle costs and be specified in a manner to encourage competitive bidding, when feasible. Materials shall be purchased in accordance with EPA CPG program under the RCRA procurement requirements. Information is available at the EPA web site (<http://www.epa.gov>).

4) The structure SF cost shall be reasonable and justifiable based on combined initial structure construction, facility installation, and projected structure maintenance operating costs. Design shall be governed by total life-cycle costs, with emphasis on minimum energy cost, to provide the best value over the facility life, not necessarily the lowest initial cost.

5) Some latitude in construction materials is necessary considering factors such as local availability and economy. If unusual local conditions make it difficult to predetermine which of two materials will have the least total cost, the designated approval authority will decide as to which material is to be used.

6) If two or more similar structural or exterior architectural treatment and design buildings are to be built, careful consideration shall be given to using like or similar construction materials.

7) Maximum utilization of operational support space shall include an emphasis on “open space” design and flexibility. All common space, such as copier room, conference room, break room, and reception area, shall be jointly shared by AT and AF personnel.

c. Future Expansion Capability. The need for building designs that permit incremental additions is highly desirable. All new and modernization projects should comply with paragraph 105.

1) The design space allocation shall include 25 percent unassigned growth space unless the allocation conflicts with local requirements.

a) Planned future expansion space may be utilized as storage space until required for operational or administrative expansion.

b) The design criteria for some facilities may be so restricted from the allowable SF

standpoint that the functional efficiency will leave little room for expansion from within the structure.

c) Therefore, the designer shall give thought to future additions by incremental or selective addition to the structure.

2) Proper consideration should be given in the initial design to ensure that utility and cable trays do not encroach on dedicated exterior expansion space. Careful planning of those functions and spaces most likely to experience future growth will reduce the likelihood of building expansions or premature facility obsolescence.

3) Control Cab. The initial design will be for a particular level of activity, plus ten years projected growth.

a) Expansion in the cab will be limited to the addition of personnel and equipment.

b) A change in physical size or configuration would mean a complete redesign of the cab structure. Future exterior expansion would normally be the addition of radar, antenna, etc.

c) The designer is advised to consider the cab as having a fixed size, configuration, and height and provide expandable/modular casework elements within the cab for future requirements.

d) Space limitations require that replacement systems shall not exceed space occupied by the system being replaced.

4) Tower Shaft. Expansion in the shaft structure would normally be to increase cab height or add additional equipment. Some shaft designs may have the capability of expansion in the form of additional floor space on one or more undeveloped levels, and initial design consideration should be given to these areas. Planning future extension to increase control cab height by incremental tower shaft structural element additions is not normally considered a practical solution with current technology. It is preferable to view the shaft as a fixed height element and design accordingly.

5) Base Building. The TRACON operations area is usually housed in the base building and has considerable growth potential. The base building facility design shall provide future expansion capability for the equipment room, TRACON, and related elements, including parking. Structural column bay spacing should facilitate expansion of key functions outward or upward. Planning for upward expansion is generally considered less desirable.

6) The effect of incremental additions should be considered when selecting HVAC, lighting, and other systems.

d. Facility Model.

1) ATCT/TRACON facilities are highly complex structures containing a variety of advanced technological elements and administrative functions and serving the public interest in the ever changing and expanding industry of air transportation. Matching the growth of aviation

with inherent facility expansion is the key to basic concept modeling.

2) Whereas no limits are placed upon using new technologies and design skills, the history of ATCT/TRACON design in the United States indicates that the preferred design for ATCTs is a basic facility model of a non-functional tower shaft with an elevator to support the cab, accompanied by a support base building of one or two stories adjacent to the shaft.

3) A direct path corridor link, using non-combustion materials, connects the base building with the shaft.

4) Cab and shaft are fixed elements, and the base building is readily expandable.

91. QUALITY STANDARDS. The quality standards of construction shall be based on the actual operating facility requirements and the information contained within this order. The facilities shall be considered as permanent construction. The design of ATCT/TRACON facilities shall emphasize sound planning, which, in turn, will develop a quality standard. The ATCT/TRACON structure design and construction shall be consistent with those structures constructed under good commercial practice.

a. Exterior Materials. Factors that enter into the exterior materials selection process are the following:

1) Functional Requirements. The use of both structural and finish materials shall be consistent with simple functional design and shall be appropriate for local climatic conditions.

2) Fire Safety. The exterior materials used shall have high resistance to burning. See paragraph 112 for additional fire safety requirements.

3) Expected Use Tenure. The materials used shall provide a normal maintenance life projecting at least ten years past commissioning. Additionally, 25 percent unassigned growth space for equipment room and TRACON shall be provided unless such an allocation conflicts with local requirements.

4) Appearance. The appearance of exterior materials shall be suitable for and aesthetically compatible with the design.

5) Construction Costs. Exterior designs should be aesthetically pleasing and yet simple enough to incorporate materials economy and construction efficiencies where practical.

6) Low Maintenance. Exterior materials should be designed for minimal recurring maintenance whenever possible.

7) Seismic Considerations. Pre-cast tilt wall designs are prohibited in very high National Earthquake Hazard Reduction Program (NEHRP) seismic zones (Zones 6 and 7).

8) Energy Conservation. The exterior design and materials should be selected for maximum energy conservation consistent with other design requirements.

b. Interior Materials. Factors that enter into the selection process of interior materials are the following:

1) Functional Requirements. Both structural and finish materials shall be consistent with a simple functional design.

2) Fire Safety. The interior materials used shall be fire-resistive construction, shall be selected to minimize the emission of toxic fumes, and shall meet the requirements set forth in paragraph 99. See paragraph 112 for additional fire safety requirements.

3) Expected Use Tenure. The materials used shall provide a minimum 20-year life with normal maintenance.

4) Appearance. The interior appearance shall be both pleasing and aesthetically compatible with the overall design.

5) Construction Costs. Interior designs shall avoid unnecessary costly construction details and overly expensive materials. The nature of the design itself should be simple and economical.

6) Hard Use Areas. In areas such as entrances, lobbies, corridors, toilets, elevators, locker rooms, stairs, ready rooms, break rooms, and the control cab, provision shall be made to select floor and wall finishes, trim, stair details, hardware, toilet fixtures, lighting, partitions, cabinet work, and accessories that have good durability and wearability and that will withstand hard in-service use while requiring minimum maintenance or replacement.

7) Acoustic Requirements. Areas such as mechanical and TRACON rooms shall be insulated to contain noise. Noise abatement engineering techniques should be employed throughout the building.

8) Low Maintenance. All materials considered for interior use should require minimal maintenance under normal usage.

SECTION 2. LIFE SAFETY REQUIREMENTS

92. GENERAL. This section provides the designer with life safety information necessary to plan and design ATCT/TRACON facilities and is not a substitute for codes and standards in force for local jurisdictions. All life safety requirements shall comply with OSHA, Order 3900.19, 29 CFR 1960.20 and NFPA 101. Security requirements established shall be reviewed to determine that no conflicts exist with life safety requirements.

93. OCCUPANCY LOADS. Since ATCT/TRACONs have well defined work areas, workstations, and operational positions, occupancy loads are determined by actual count of the maximum number of stations for the fully expanded design. The A&E firm shall use a rational method to determine occupant loads and document method and results in site file with a copy the Terminal Facilities Program Office. ATB-300. Occupancy loads shall be determined in

accordance with 29 CFR 1960.20, Alternate Standard for Fire Safety in Airport Traffic Control Towers and NFPA 101. Construction type shall be in accordance with 29 CFR 1960.20 and the model building codes.

a. Control Cab. That portion of a building or structure used for the control of aircraft by visual observation, radio communication, and/or radar by ATC specialists.

b. Tower Shaft. That portion of a building, facility, or tower that structurally supports a control cab used for housing minimum electrical, mechanical, and electronic equipment. Each floor area is normally less than 1,500 SF.

c. Base Building. Buildings used for housing support equipment and personnel for ATC activities.

d. Building Egress. The building egress shall be designed in accordance with 29 CFR 1960.20, IBC, and NFPA 101.

94. EXIT REQUIREMENTS.

a. Definition. An exit is a continuous and unobstructed egress means to a public way.

b. Purpose. The purpose of exit requirements is to provide accepted standards that would ensure a safe means of egress for occupants of ATCT/TRACON facilities in an emergency situation.

c. General. Every building, structure, or portion thereof shall be provided with exits as required by these paragraphs. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall take precedence.

d. Exit. Exits shall be designed in accordance with NFPA 101 and 29 CFR 1960.20.

e. Equipment Seismic Security. Equipment along the egress path shall be secured to the wall or ceiling to meet the desired facility seismic safety level requirements.

95. DOORS.

a. General. These paragraphs shall apply to every required exit door.

b. Swing. Exit doors shall swing in the direction of exit travel when serving any hazardous area or when serving an occupant load of ten (10) or more. Building door size, except tower cabs, shall meet FED-STD-795 and NFPA 101 requirements.

c. Width and Height. Every required exit doorway size shall accommodate a door, not less than three (3) feet wide and not less than six (6) feet, eight (8) inches high. When installed in exit doorways, exit doors shall open at least 90 degrees and shall be mounted so that the clear exit way width is not less than 32 inches.

d. **Exit Door Hardware.** Panic hardware is required on all exit and corridor doors serving ATCTs and TRACONS. The doors shall swing in the direction of exit travel and be opened from inside without the use of a key or any special knowledge or effort.

e. **Special Doors.** The building, except the tower cab, revolving, sliding, or overhead doors shall not be used for required exits except in compliance with FED-STD-795 and NFPA 101 requirements.

96. CORRIDORS.

a. **General.** These paragraphs shall apply to every corridor serving as a required exit for a ten (10) or more person occupant load.

b. **Width.** Every required exit corridor shall be not less than 44 inches wide or comply with codes noted in paragraph 21.

c. **Height.** Exit corridors shall have a clear height not less than seven (7) feet, six (6) inches, measured to the lowest projection from the ceiling.

d. **Dead Ends.** Corridors with dead ends are permitted when the dead end does not exceed 20 feet long beyond an exit or an adjoining corridor.

e. **Construction.** Exit corridor walls serving a base building occupant load of 30 or more, or an ATCT occupant load of ten (10) or more, shall not be less than one-hour fire-resistive construction, and the ceilings shall be not less than that required for a one-hour fire-resistive floor or roof system.

97. STAIRWAYS.

a. **General.** Every stairway serving any building or portion thereof shall conform to these paragraph and code shaft-rating requirements.

b. **Width.** Stairways serving a total occupant load of more than 50 shall be not less than 44 inches in width. Stairways serving a total occupant load of 50 or less shall not be less than three (3) feet wide. Stairways serving a total occupant load of ten (10) or less shall not be less than 30 inches wide between the cab floor and adjacent floor only. Handrails may project from each side of a stairway and shall not project more than 3-1/2 inches into the required width.

c. **Rise and Run.** The rise of every step in a stairway shall not exceed seven (7) inches and the run shall not be less than 11 inches. Exception: Stairways serving a total occupant load of ten (10) or less and stairways to unoccupied roofs may be constructed with an 8-inch maximum rise and 9-inch minimum run. Stair treads shall be non-skid materials.

d. **Circular or Spiral Stairways.** Circular or spiral stairways shall not be used in ATCTs.

e. **Landings.** Every landing shall have a dimension measured in the direction of travel equal to the width of the stairway. There shall be not more than 12 feet vertically between landings.

98. SMOKE PROOF ENCLOSURES. All ATCT facilities shall meet 29 CFR 1960.200 requirements concerning smoke proof enclosures.

a. A smoke proof enclosure shall consist of a continuous stairway enclosed from the highest point to the lowest point by fire-resistive construction walls. The stairway enclosure shall be designed so that combustion product movement into the enclosure, produced by a fire occurring in any part of the building, shall be limited as required by applicable codes and standards.

b. Natural Ventilation. Vestibule and stairway doors shall have a 1-1/2 hour fire-resistive rating and shall close automatically, and manual door holding devices shall not be used. A vestibule shall be located at the stairway entrance of each occupied level above the ground floor. Each vestibule shall be ventilated to the outside through an opening in an exterior wall. An exhaust opening to the outside at the top level of the stair shaft or level below the cab shall be provided. If the stairway continues directly into the cab without enclosure by two-hour fire-resistive construction on the floor below, provide a dampered exhaust hood in the cab roof for emergency. Dampers shall open automatically upon activation of a smoke detector. Openings shall be sized and located to facilitate exhaust of heat and smoke and the intake of fresh air.

c. Mechanical Ventilation.

1) Doors from the building into the vestibule shall have 1-1/2 hour fire-resistive rating and automatic closures. Doors from the vestibule to the stairway shall have a 20-minute rating with smoke and draft seals.

2) The minimum vestibule dimension shall be 44 inches wide by 72 inches in the direction of exit travel. The vestibule shall be provided with one air change per minute supply and exhaust with an under-pressure maintained at 0.05 inch of water column (WC) relative to the atmosphere and a minimum under-pressure of 0.1 inch of WC relative to the stair shaft. Separate ventilation ductwork shall be used only for that purpose. The vestibule ceiling shall be 20 inches higher than the top of the door opening to serve as a smoke and heat trap. Supply air shall enter the vestibule within six (6) inches of floor level and exhaust within six (6) inches from the top of the smoke and heat trap.

3) The stair shaft shall be provided with a dampered relief opening at the top and supplied mechanically with sufficient air to discharge a minimum of 2,500 cubic feet per minute while maintaining a minimum positive pressure of 0.05 inch of WC in the shaft relative to the atmosphere with all doors closed. The force resisting door opening shall not exceed 15 pounds.

4) Shaft and vestibule lighting and mechanical ventilation systems shall operate upon activation or failure of smoke detectors. The mechanical ventilation system and stairway/ vestibule lighting shall be on the emergency power generator system.

5) An emergency exhaust fan shall be provided in the roof of the control cab and at other occupied levels. Upon activation of a smoke detector located in the return air duct of the air conditioning system, the air conditioning supply fans shall be deactivated. The exhaust fan shall be capable of being manually activated and shall flush return air from the building without recirculation through the building.

99. FIRE PROTECTION.

a. General. Where specific materials, construction types, or fire-resistive protection are required in this order, they shall always equal or exceed the combined minimum Order 3900.19, 29 CFR 1960.20, NFPA 101 and the applicable model building code requirements. Materials, construction types, or fire-resistive protection that will afford equal or greater public safety or resistance to fire may be used.

b. Combustibility of Structures. Buildings and structures for ATCT/TRACON construction are classified by their relative degree of combustibility. Construction types are covered in the IBC. Type I, II, or IV shall be used, or the structure shall be protected non-combustible construction. See paragraph 166a for structural requirements.

c. Fire Protection Analysis. Each phase of a site adaptation design document submittal by an A&E firm shall be accompanied with a fire protection assessment by a registered and licensed professional engineer. The final assessment document shall be signed and sealed by the fire protection engineer. Contained in this fire protection analysis will be an assessment of the overall facility fire protection features including fire extinguishing, smoke management, detection and alarm, communication, fire resistance, egress, and other pertinent fire protection and life safety issues.

d. Fire Protection System Design. Fire protection systems are designed in accordance with paragraph 102.

100. FIRE-RATED PARTITIONS.

a. These construction components shall be installed in buildings to separate areas of hazardous occupancies, such as mechanical, generator, elevator, battery rooms, and technical equipment rooms (include communication, radar, telephone, and TRACON rooms) from each other and from areas of ordinary or light hazard occupancy such as stairways, corridors, offices, training rooms, ready rooms, and the control cab.

b. Fire resistance rated partitions comprising room enclosures shall be constructed in accordance with NFPA 75, Standard for the Protection of Information Technology Equipment; NFPA 101, Life Safety Code; NFPA 110, Standard for Emergency and Standby Power Systems; 29 CFR 1960.20; and the applicable model building code for all other building areas.

c. Penetrations through fire resistance rated assemblies shall be through-penetration fire-stopped with a listed assembly. All penetrations through fire-rated partitions shall be sealed to maintain the fire rating. Fully sprinklered buildings may meet these requirements by alternate means.

TABLE 5-1 (DELETED)

101. FIRE AND SMOKE DETECTION. Automatic smoke detection and alarm systems shall be installed in all ATCT/TRACON facilities in accordance with Order 3900.19; 29 CFR 1960.20; and NFPA 72, National Fire Alarm Code. The fire alarm and detection system shall be

a Class A system such that the system operates during the occurrence of signaling or notification circuits.

a. Spot type smoke detectors should be located throughout the ATCT and in electrical equipment areas and mechanical equipment rooms in base buildings.

b. Duct type smoke detectors should be located in air handling units and in the stair pressurization fans.

c. Heat detectors should be utilized in areas where smoke detectors would not be appropriate, such as E/G rooms, elevator machine rooms, and kitchen areas.

d. Manual alarm pull stations shall be provided at each exit on every occupied floor or equipment level.

e. Smoke detectors shall be installed at each enclosed elevator landing or lobby that, when activated, shall return the elevator to the lowest level that does not have an alarm, and the power operated doors shall open automatically and remain open.

f. At least one smoke detector and one alarm bell shall be installed on every occupied level and at a location where they can be heard throughout the facility.

g. There shall be a master fire control panel monitoring the different fire zones of the facility.

h. Any facility that is constantly staffed by FAA personnel should be locally monitored at an appropriate location within the structure.

Exception: Elevators may be used as a second means of egress in accordance with ASME A17.1, Safety Code for Elevators, and IBC paragraph 1003.2.13.3.

i. The master fire control panel must be located at the fire department entry point.

j. A remote annunciator shall be located in the ATCT cab and TRACON operations room that allows the operators to acknowledge and silence the audible alarms on the remote annunciator panel.

k. The annunciator panel shall be of the addressable type.

l. Other parts of new ATCT and TRACON facilities shall be equipped with both horns and strobes per NFPA 72. Care shall be given to the placement of horns so they do not disrupt ATC operations.

m. Only visible notification appliances are to serve the tower cab and TRACON control room. The visible notification appliances provided for these areas must be incandescent strobes with red lens.

n. All Tower and TRACON fire and smoke detection systems shall be externally monitored in accordance with NFPA 72. An independent professional firm that is normally engaged in this type of business can perform this function or report the status directly to the fire company.

o. The TRACON and ATCT cab control room fire alarm light shall be designed to annunciate in a dark environment. The alarm design shall not contain an alarm buzzer or white strobe flasher in the TRACON control room. The visible notification appliances provided for these areas must be incandescent strobes with red lens. The aural fire alarm shall be compatible with the critical controller communications.

102. FIRE EXTINGUISHING SYSTEMS. Fire extinguishing systems are required for ATCT, Base Building, and Stand Alone TRACON facilities. A licensed fire protection engineer shall sign fire extinguishing system design.

a. National Fire Protection Association (NFPA) and Order 1600.54, FAA Automated Information Systems Security Handbook, requirements shall guide the fire extinguishing systems design.

b. Operational and equipment areas will be dry pipe, pre-action systems; all others will be wet pipe.

c. Fire extinguishing system piping shall be protected from environmental conditions, including freezing and seismic, detrimental to the system performance.

d. ASME A17.1 contains additional requirements that shall guide the fire extinguishing design in regards to sprinkling the elevator shaft and elevator machine room.

103. FIRE EXTINGUISHERS. NFPA 10, Standard for Portable Fire Extinguishers, shall be referenced to specify ATCT/TRACON facilities portable fire extinguisher requirements.

104. SAFETY.

a. The final design shall include all features comply with the established building and safety codes and regulations and applicable OSHA and ANSI design standards.

b. Particular attention shall be given to safety features such as handrails, non-slip treads, stairway head clearances, ladders, access hatches, mechanical and electrical equipment guards, hazardous energy source lockout, and other safety item corrections determined in facility and equipment design reviews.

c. All drawings shall be reviewed by the Regional Safety Manager for safety issues such as lockout points, anchor points, confined spaces, fall hazards, noise hazard areas, and areas where eyewash stations or emergency showers may be necessary. These issues should all be addressed at the design level to minimize the hazards involved with the day-to-day activities and maintenance of the facility.

d. Location for eyewash stations or showers shall be identified.

105. PHYSICALLY DISABLED PROVISIONS. Base buildings shall be designed in accordance with FAA Order 4660.2, Accessibility of FAA Buildings to the Physically Disabled, provisions and all applicable UFAS regulations to facilitate disabled access. Non-functional tower shaft and cab designs are not required to comply with these orders, standards, and regulations as noted in the IBC; however, many of the disabled type access features such as non-slip floors and stairs, handrails, and color contrasts shall be incorporated in the ATCT structure.

106. STANDBY POWER SYSTEM. All ATCT facilities shall contain standby power systems as defined in FAA Order 6950.2, Electrical Power Policy Implementation at National Airspace System Facilities. See CHAPTER 9 for additional standby power requirements. Other building loads may be added to the E/G. See paragraph 288 for additional information.

a. ATCTs more than 65 feet high shall additionally have standby power in accordance with the National Electrical Code (NEC) Article 700 and NFPA 101 for emergency lighting, automatic fire alarm system, electrical fire pump, central control station, mechanical equipment for smoke-proof enclosures, and the elevator.

b. ATCTs less than 65 feet in height shall have emergency power in accordance with the NEC, Article 701, Legally Required Standby Systems for emergency lighting, automatic fire alarm systems, mechanical equipment for smoke-proof enclosures, and the elevator if required as a second egress means.

107.-110. RESERVED.

SECTION 3. GENERAL REQUIREMENTS

111. ELEVATORS AND PLATFORM LIFTS

a. An elevator in the ATCT shall provide for both personnel and freight lift from the ground level to the junction level below the control cab.

1) A mechanical platform lift shall be provided for the movement of supplies and equipment into the tower cab.

2) The minimum lift dimensions shall be 30 inches by 36 inches.

b. In facilities where there is a two or more story base building design, the shaft elevator may be used for elevator access to floors above ground level.

c. In addition, a remotely controlled electrical hoist shall be provided for supplies and equipment movement in the tower cab (see paragraph 160). Elevators shall be installed in accordance with NFPA 101, Section 7-4, Elevators, Escalators, and Conveyors.

d. Elevators Operation Under Fire or Other Emergency Conditions. American Society of Mechanical Engineers (ASME/ANSI) A17.1, Safety Code for Elevators and Escalators, shall be

used for elevator design and operation under emergency conditions. The ATCT elevator shall be available for use when the facility is operating on standby power without requiring manual intervention at the ground level or the operation of a transfer switch to place the elevator on the standby power source. During a fire alarm condition the elevator shall automatically return to the elevator lobby on the ground floor in accordance with ASME A17.1.

TABLE 5-2. ADDITIONAL REQUIREMENTS FOR ELEVATORS

ATCT FACILITY TYPES - OCCUPANCY GROUP A			
ELEVATOR CAR DESIGN REQUIREMENT	CONTROL CAB SIZE		
	UP TO 250 SF HEIGHT TO 112'	250 SF TO 500 SF HEIGHT 114' TO 168'	OVER 500 SF HEIGHT OVER 170'
Car Platform Size	5 feet x 6 feet	5 feet x 6 feet	5 feet x 7 feet
Minimum Capacity	2,000 pounds	2,500 pounds	2,500 pounds
Minimum Door Opening	3 feet, 0 inches	3 feet, 6 inches	3 feet, 6 inches
Cab Floor to Clear Ceiling Height (Minimum)	7 feet, 5 inches	7 feet, 5 inches	7 feet, 5 inches
Travel Speed	100 to 350 feet/min.	200 to 350 feet/min. *	200 to 350 feet/min *

*100 feet/minute (max) when on E/G.

TABLE 5-3. [DELETED]

e. Elevator Design. Elevators are required in all ATCT facilities and in IBC, Occupancy Group B base buildings two or more stories in height and designed in accordance with ASME A17.1. The hydraulic elevator may be installed in accordance with applicable standards when site conditions warrant; otherwise, electric or battery powered traction elevators shall be installed. There shall be an elevator landing at all equipment levels and occupied levels. A telephone shall be provided in the elevator car. Disabled considerations shall be reviewed and implemented in the elevator car design.

f. HVAC. Heating and ventilation shall be provided in the elevator car where climatic conditions warrant.

g. Elevator Speed. Elevator travel speeds should be minimum in ATCT/TRACON facilities.

CAUTION: Current draw down and voltage drop on power generating systems resulting from elevator activation on emergency power may affect sensitive electronic equipment in the TRACON.

h. Door Operation. The elevator door operation shall be electrical. Elevator access to each intermediate level shall be a key-operated button.

i. Codes. The elevator installation shall meet current local codes and the following codes: American National Standard Safety Code for Elevators and Escalators, ANSI A17.1, A17.1a,

A17.1b, American Standard Practice for the Inspection of Elevators, Inspectors Manual (A.S.A. A17.260); National Electric Code; and Underwriter's Laboratories Building Materials Directory.

112. MATERIALS. Interior finishes shall be installed in accordance with NFPA 101 and 29 CFR 1960.20 requirements.

a. Exterior Walls. The designer should select ATCT/TRACON facility exterior wall construction based on structural requirements, noise reduction at airports, architectural appearance, insulating and thermal properties, environmental attributes, and durability.

1) The exterior materials, including structural and finish materials, shall be selected, designed, manufactured, and installed to limit the development and spread of fire, flame, and the combustion products, and shall meet the applicable model building code requirements.

2) Cast-in-place concrete control joint construction to prevent cracking has previously been used by the FAA. Color and texture of concrete constructions should be specified based on locally available aggregates, cements, and techniques.

3) Control towers constructed of concrete or masonry shear walls are limited to total height of 160 feet, in seismic design category D, using the maximum value for the short period and the maximum value for the long period as a minimum, in accordance with IBC.

4) Color selection should be uniform, light to medium low emissivity and non-glare characteristics, and pleasing in appearance.

5) Exterior wall construction should maximize resistance to conditioned air thermal leakage. Each exterior face of the structure should be considered unique and components selected based on the effects of solar gain, sun azimuth, wind, etc.

b. Interior Walls. Only rough construction of interior wall partitions is included in this paragraph. For interior wall finish materials, see CHAPTER 5, Section 4. The following partition types shall be considered.

1) Hollow architecturally finished CMUs for load-bearing walls shall be reinforced and grout filled.

2) Architecturally finished CMUs or common brick faced with ceramic shall be reinforced and grout filled.

3) Thin or solid plaster partitions for curved surfaces only.

4) Gypsum wallboard or pre-finished gypsum wallboard.

5) Ceiling height metal studs/gypsum wallboard pre-fabricated units acoustically treated.

6) Prefabricated noncombustible panels.

c. Windows. Window types should be selected with full functional cognizance and only after consideration of architectural appearance, safety requirements, noise transmittance, optical requirements, solar gain, heat flow through the building envelope, affect on occupants, natural heat and light, natural ventilation, and security. Windows shall be installed in accordance with FAA Order 1600.69.

1) Control cab glazing should have excellent optical transmission, double pane or triple pane thermal assembly for comfort, and sized to minimize deflection in high winds.

2) Special attention should be given to cab glass anchorage details, providing for structural compatibility and thermal expansion.

3) Provision shall be made for replacement of cab glass such as installation of necessary attachment point for removable davit-type assemblies to be used to position the glass. Assemblies may be removed and stored off-site.

4) Glass sizes and thickness are based on specific geographic location wind load requirements. Two- or three-pane insulating glass should be used at the building envelope.

5) Exterior sun control devices for minimizing solar gain are preferred. These include awnings, overhangs, reflective film, shutters, or tinted glass.

a) Low emissivity (E) coating should be considered for windows.

b) Interior sun control devices for controlling natural light may include window shades, blinds, drapes, and screens.

6) Windows should be considered for all administrative office spaces and break rooms.

7) Windows should be avoided in electronic equipment rooms, TRACON rooms, storage rooms, and mechanical/electrical rooms.

8) Glazing openings subject to accidental human impact should be glazed with tempered safety glass or equivalent.

9) All windows at grade level should be tempered.

d. Doors and Frames. Door types and sizes for each project should be standardized to the maximum extent practicable. Types and sizes shall be suited to the functional and fire safety requirements. Doors shall meet requirements of FAA Order 1600.69.

1) Hollow Metal Doors.

a) These doors shall be full flush steel construction and shall be at minimum 1-3/4 inches thick.

b) In general, hollow metal type doors shall be used in exterior openings and interior openings where doors are subjected to hard usage and where a degree of security is required.

- c) All exterior hollow metal doors shall be galvanized and insulated.
- 2) Wood Doors.
- a) Wood doors shall be flush type paint, veneer, or Formica clad solid-core doors and shall only be used for interior spaces.
 - b) Wood doors shall be 1-3/4 inches thick.
- 3) Weather-stripping. Where no vestibules are provided, exterior doors shall be weather-stripped.
- 4) Thresholds shall be provided at all exterior door openings.
- 5) Double doors shall be provided with removable mullion or astragal.
- 6) Special doors.
- a) Fire doors, firewalls, and fire partitions installation shall meet NFPA 101, NFPA 80A, and FAA Order 3900.19 requirements.
 - b) Labeled doors shall be installed in walls requiring fire labeled construction and shall meet NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures, requirements.
 - c) Other types of doors: rolling, sliding, folding, soundproof, accordion, and other special types, shall be installed as required.
 - d) Use stock types and sizes where possible.
- 7) Door Frames.
- a) Steel. Use combination steel frame and trim for:
 - (1) Doors in exposed masonry walls.
 - (2) Doors in conjunction with walls having plaster, gypsum wallboard, and ceramic tile finish.
 - (3) Doors in partitions framed with metal studs. Grout-filled frames are used where noise transmittance reduction is required, such as entrance doors.
 - (4) Structural Steel Channel Frames. Structural steel channel frames shall be used for rolling doors and where door weight requires.
 - b) Wood. Wood door frames may be used for closets or for special wood-frame construction.
 - c) Aluminum. Aluminum door frames shall be used only where aluminum doors

have been authorized.

(1) Door Hardware. Special attention shall be given to the selection of proper and serviceable door hardware. Hardware shall be adequate for intended use. High style, premium priced hardware and material, such as stainless steel and white bronze, shall not be selected except for minor components or parts when their use is standard with the manufacture such as keys for locks, floor plates, or floor hinges.

d) See Order 1600.6 for lock and key system requirements.

e) Door hardware shall meet FAA Order 4660.2 physically disabled accessibility and UFAS requirements.

f) Fire rated door hardware shall meet NFPA 80A requirements, manufacturer's recommendations, and the required assembly listing.

g) Lever operated, push type or U-shaped door handles are required in accordance with FED-STD-795 and 29 CFR 1960.20.

e. Floor Finishes. The floor finishes shall be one of the following listed types. The areas where each may be used will be indicated in CHAPTER 5, Section 4, Space Requirements. Floor finishes shall meet the IBC fire exposure condition requirements.

1) Integral monolithic concrete with troweled finish.

2) Applied cement finish with troweled surface on concrete slabs or integral monolithic concrete with troweled finish. A hardener may be used where cement or concrete finish is not covered by other materials.

3) Unglazed ceramic tile. The tile shall be set with either thin set organic adhesive with grouted joints, or set with suitable Portland cement mortar.

4) Quarry tile shall be set with suitable Portland cement type setting and jointing mortar or by thin set organic adhesive with grouted joints.

5) Vinyl composition tile or equal floor finish shall be used where a resilient floor tile type is required; 1/8-inch thickness is desirable.

6) Special purpose floor finishes may be rubber tile, sheet vinyl floor covering, epoxy, slip resistant, acoustic, or other appropriate special materials. These finishes would be used only in special areas where justified for functional use. Special areas may include equipment, janitor, and electrical/mechanical rooms.

7) Carpeting shall be cut pile construction and shall be first quality woven material or equivalent. Carpet tiles shall have performance factors of less than 2.0 kilovolt (kV) static generation under worst possible conditions and be considered for high traffic carpeted areas.

a) Carpets, in general, should be used to enhance acoustical control.

b) When carpet is installed on top of raised access floor, the carpet squares should have the same dimensions as the raised floor panels.

8) All areas utilizing computer and facilities electronic equipment shall have static dissipative type floor finish materials with a surface resistance between 2.5×10^4 and 1×10^9 ohms measured in accordance with the American National Standards Institute (ANSI) Electrostatic Discharge Standard, ANSI ESD S7.1, Floor Materials – Resistive Characterization of Materials. These materials prevent harmful static electricity levels from being generated and quickly drain existing charges from mobile personnel who enter an area where static electricity shall be controlled. Carpeting shall be installed in accordance with FAA-STD-019. Administrative space carpet shall use, as a minimum, carpet tiles meeting paragraph 112.e.7) requirements.

9) Carpet or tile square installation on raised floor sections requires installation in accordance with FAA-STD-019 and manufacturers' specifications for these floor surface types.

f. Wall Base Materials. Wall base materials shall be vinyl, rubber, ceramic, masonry, or concrete. Wall base materials shall be applied over fire protective materials at fire rated walls. Select wall base materials that are appropriate for cleaning adjacent flooring.

g. Finish Materials for Partitions. Partition finishes for spaces are specified in Section 4 of this chapter. Water-resistant wallboard should be used in rooms subject to water damage.

1) Exposed Masonry. Masonry units that are exposed shall have workmanship of type and character compatible to the function of the space.

2) Plaster. Plaster may be applied to lath or directly to masonry.

3) Gypsum Wallboard. Partitions and ceilings shall be constructed of 5/8-inch thick, fire rated, Type X, gypsum board. Recycled products should be considered for this application.

4) Glazed Ceramic Wall Tile or Structural Facing Units. These materials shall meet the industry standard for quality, finish, and workmanship.

5) Vinyl Wall Coverings. These coverings shall be installed over smooth back-up materials for specific finish treatment. The local environmental conditions shall be evaluated when using vinyl wall coverings.

6) Wood Paneling. Wood paneling may be used in moderation for specific finish treatments and shall be installed on a noncombustible backing material in accordance with 29 CFR 1960.20.

7) Special Wall Coverings. Special wall coverings, such as noise absorbing panels, acoustical units, and special installation of other acoustical systems, shall be held to areas where special acoustical treatment is required.

8) Metal Panel or Prefabricated Metal Partitions. These may be used when it becomes part of a flexible wall partitioning system.

9) Pre-finished Gypsum Wallboard. This may be used in accordance with fire protection requirements.

h. Ceiling and Ceiling Finishes. Finished ceilings are required in all administrative and operational areas. They are not required in electronic equipment rooms, storage areas, or mechanical and E/G rooms. Consideration shall be given to safety, acoustics, appearance, maintenance, energy conservation, and illumination when selecting a ceiling type. Ceiling tiles with high acoustical properties should be used.

1) Direct Applied Acoustical. These materials are useful for remedial work to enhance acoustical control.

2) Acoustical Suspension.

3) Gypsum Wallboard.

i. Painting. The facility exterior and interior paint colors should be neutral or selected based on best commercial practice and local considerations. The local environmental conditions shall be evaluated when selecting paint. The employee input shall be consistent with labor contract agreements.

j. Building Insulation. Energy efficient design requires all conditioned spaces within ATCT/TRACON facilities be thermally insulated to minimize heat transfer through the building thermal envelope. The insulation, type, and thickness should be based on economically justifiable design criteria. It may be anticipated that the facility will function for many more years past its design life. With energy costs increasing rapidly, the design should have relatively high thermal resistance characteristics. The building insulation shall be selected and installed in accordance with Building Owners and Managers Association (BOMA), International Energy Conservation Code, local building codes, and Executive Order 13123.

1) Exterior walls should have the following thermal characteristics:

a) Material, color, and finish selected for low emittance under atmospheric conditions.

b) Airtight joints.

c) Thermal breakthrough metals, concrete, and masonry.

d) Moisture condensation protection for fiber bat insulation, from internal and external sources, as applicable.

e) Ventilation provisions for fiber bat insulation.

f) Fully insulated wall cavities without air gaps. Do not use loose fill insulation.

g) Non-flammable insulation.

- h) Minimum heated and cooled structure wall thermal resistance should be R-19.
- 2) Roofs shall have the following thermal characteristics:
 - a) Material color and texture selected for low emittance under atmospheric conditions.
 - b) Moisture protection for all insulation types and ventilated insulating materials.
 - c) Minimum thermal resistance, R-30.
- 3) Foundations shall be constructed as follows:
 - a) Insulated slabs-on-grade within four (4) feet of the perimeter when adjacent spaces are heated.
 - b) Thermal isolation between foundation walls and floor slabs.
 - c) Insulated basement foundation walls on the exterior side for full height of wall.
 - d) Insulated perimeter grade beams to frost depth.
 - e) Isolated entry stoops from heated floor construction.
 - f) Minimum foundation insulation should be R-10.
- 4) Earth bermed and underground base buildings require special consideration.
 - a) Use of soil as insulation should be carefully evaluated, except in dry sandy soils.
 - b) Some of these designs can take advantage of the thermal mass effect of the earth that typically maintains a constant temperature of 55 degrees F, at eight (8) to ten (10) feet below the surface.
 - c) These structures require adequate drainage, waterproofing, and water-resistant exterior insulation to function effectively.
- k. Sound Control. Sound or noise control shall be incorporated in ATCT/TRACON facility designs.
 - 1) The design shall consider both internal and external sound source control in accordance with 29 CFR 1960.20.
 - 2) Where noise control is a concern, whenever possible the building orientation on the site and the room location in the building shall be placed to reduce sound penetration to appropriate spaces.
 - 3) Conventional sound-retardant building materials or systems shall be used for construction.

4) Ceiling tiles with high acoustical absorption properties should be used.

5) The services of an acoustical engineering consultant should be utilized where noise control problems are critical or severe. Special construction to reduce aircraft noise transmission into the space shall be considered early in the space design. Two types of sound control are required for ATCT/Buildings.

6) Sound attenuation is necessary for control of disturbance from high energy noise levels produced by aircraft engines, E/Gs, mechanical equipment, etc.

7) Where feasible, E/Gs should be located external to the base building/tower shaft envelope to reduce sound and vibration transmission.

8) Use of sound absorbing materials, like sound board for walls, roofs, and partitions is effective in minimizing noise transmission into adjacent spaces.

9) Lightweight construction in areas in the vicinity of aircraft movements shall be avoided.

10) Wall construction should be sealed and airtight.

11) Acoustical control is recommended to minimize disturbance from intrusive speech and other noises and assure a measure of privacy for the conduct of sensitive business functions. Full height, airtight, gypsum wallboard partitions; sound attenuation blankets in wall cavities; acoustical ceilings; and carpeting may be used for effective acoustical control.

12) Acoustical control is required around toilet rooms, playback rooms, conference rooms, training rooms, private office spaces, TRACON, and other areas as required by the design. Additionally, walls in the TRACON and playback rooms shall be acoustically treated to reduce reflected noise generated within the space. Acoustically treated board should be used for walls in areas such as quiet rooms and break areas. Floor carpet shall not be used on wall surfaces to control sound.

1. Roofs. Roofs shall be designed to provide protection from moisture penetration and prevent problems such as water ponding. The preferred design is a sloped roof. Roof slope shall be 1/4 inch per foot minimum. Single-ply, thermoplastic membrane type with heat welded seams or a two-ply modified system with a base sheet with insulation may be used, but avoid allowing gravel ballast to be present on top of single membrane roofs.

1) All roofs shall slope to drains and designers shall pay attention to curbs, flashing, and penetrations. Roof construction shall be 20-year serviceable life span.

a) There are different roofing systems that are acceptable such as metal standing-seam roofs; however, they shall meet or exceed the requirements for moisture protection.

b) Roofs shall be finished in a light color for reduced cooling loads, unless other considerations override.

c) See paragraph 154 for guardrail protection requirements that may be applicable to this paragraph.

2) Roof drains shall be placed on roofs at proper locations and at elevations to insure complete water drainage from the roof.

a) Provide auxiliary scuppers or overflow drains to prevent excess or accidental flooding on roof.

b) Overflow drains and piping shall be installed independent of the roof drain lines to a point in the main drainage system sized two times the diameter of the overflow and roof drain piping.

c) Designers shall provide details to minimize damage and injuries resulting from falling ice from roofs in winter.

3) Where antennas are required, roofs, adjacent walls, or parapets shall be designed for installation and maintenance of antennas, mast guy wires, etc. Flashings and counter flashings shall be carefully designed to prevent moisture penetration. Roofing material penetration shall be avoided to the maximum extent practical.

4) Provide roof walkways for frequent window washing and servicing/maintenance of equipment. Walkways shall be permanent structures such as, asphalt plank, redwood, treated 2x4s, or pre-cast concrete units set in bituminous plastic cement and compatible with the type of roofing system used on the rest of the building.

5) Where employees shall work near open edges, a parapet or railing shall be provided in accordance with OSHA standards; i.e., 42 inches, or have approved anchor points for employees to use as appropriate fall protection.

m. Surface Burning Characteristics of Building Materials. The materials surface burning characteristics shall meet NFPA 101, 29 CFR 1960.20, and the applicable model building code.

113. ENERGY CONSERVATION. Facility systems shall be designed and selected to optimize energy efficiency for local environmental conditions while providing individual occupant comfort; e.g., enthalpy controlled economizers, insulation, renewal energy technologies, and solar devices. Appliances and devices should have Energy Star rating. Energy conservation efforts shall not compromise ASHRAE 62 indoor quality requirements and paragraph 218 temperature and humidity requirements.

a. HVAC controls shall consider direct digital control (DDC) with remote sensors. Thermostat design shall consider a night set-back capability.

b. High-energy efficiency lamps with electronic ballasts shall be considered to provide adequate light in the control cab. See paragraph 294 for lighting requirements.

c. The building design shall achieve a high-energy efficient performance in accordance with FAA-STD-033, Energy Management in NAS Physical Facilities. Additionally, the building

envelope shall be designed to minimize conductive, convective, and radiant heat flow; the solar load through the tower cab glass; and maximize natural lighting, heating, and cooling.

d. Space arrangements should optimize groupings for similar lighting, heating, and cooling zones within the structure.

e. Critical computer areas shall have tight air seals and controlled outside air pressurization to minimize humidity and dust penetration.

f. Photovoltaic electrical panels shall be considered for wall and roof mounting. Wind turbines, fuel cells, and other renewable energy technologies shall be considered.

114. RAISED COMPUTER FLOORS. Raised floors shall have a maximum 18-inch clear space between the frame and the floor. Requirements for raised floors are covered in Section 4, Space Requirements.

a. Raised floors shall be electrically continuous, properly bonded, and grounded and may consist of bolted grids (stringers) or a rigid grid system. Both the rigid grid and bolted grid raised floors shall be connected to the below-floor signal reference grid system and to the perimeter ground cable with copper straps or cable that meets FAA-STD-019 requirements.

b. Alternate stringers of the bolted grid raised floor should also be bonded in accordance with FAA-STD-019.

c. A signal reference grid (SRG) shall be installed in accordance with FAA-STD-019. Raised floor panel size and weight shall meet OSHA safety as well as structural requirements. The raised floor shall support floor loading in accordance with FAA-G-2100.

SECTION 4. SPACE REQUIREMENTS

115. SPACE ALLOCATION REQUIREMENTS. All aspects of design shall be carefully weighed with respect to flexibility, adaptability, general purpose, and multiple use space. The workspace layout and arrangement shall be designed to share administrative space by various organizational elements. Consideration shall be given to providing disabled access to a percentage of administrative and non-cab operational workstations in accordance with FED-STD-795.

a. Adequate space to support the facility occupants' needs shall be provided; e.g., showers and lockers, administrative and employee relations areas, training and conference rooms, break rooms, and storage rooms as appropriate for the specific facility. Technical and administrative requirements of each ATCT/TRACON facility need to be determined on an individual site basis. Space requirements are covered in FAST.

b. Administration areas include recycling and material storage and handling such as loading docks. Specific criteria should be developed for open space design with modular furniture to

achieve maximum flexibility and utilization. Private office use should be avoided unless justified and/or authorized.

c. All non-administrative spaces that contain electronic equipment shall use an access control system in accordance with the security risk assessment (see paragraph 24). Where specific criteria are not included in this section, the general technical criteria presented in the rest of this order are applicable.

d. FAST and AMS Section 5, Space Requirements, shall be used as space allocation guidance. Additional space allowances may be made when fully justified in the appropriate programming documents.

e. In all spaces that have suspended ceilings, space (in addition to the above ceiling space for mechanical equipment and lighting) shall be provided above the ceiling for installation and access of two crossing electrical cable trays (see paragraph 305).

f. The following paragraphs in this section discuss the detailed requirements and functions of spaces in ATCT/TRACON facilities. Refer to paragraph 161 for additional information on space relationships.

116. ADMINISTRATIVE SPACE.

a. Description. Administrative space is defined in the FAST as all space, except AT operating space and AF electronic equipment rooms and maintenance areas. Therefore, all space, regardless of location, when used for offices, conference rooms, training rooms, lobbies, waiting rooms, or other administrative functions, is classified as administrative.

b. ATCT/TRACON conceptual and subsequent design drawing submittals shall list and depict sizes of the areas and rooms proposed to be used in a design.

c. On the drawing of the TRACON operations room, equipment rooms, administration areas (including drug testing, CBI, Quiet Rooms, etc.), and environmental support unit (ESU), areas shall be identified with a distinctive pattern (crosshatching, etc.).

d. The SF of each area listed on the drawing along with numbers of approved AT and AF staffing that will be located in the facility during the single largest shift will be shown on the floor plan.

TABLE 5-4. STAFFING ON LARGEST SHIFT

Group	Largest Shift	Staffing
AF	Day; 0700-1900	10
AT	Day, 0700-1900	20

e. Approved staffing studies shall provide the staffing numbers. A copy of the staffing study shall be included with the design submittal.

f. Total space provided shall be based on the largest shift – reference Acquisition Management System (AMS) Real Estate Guidance, Appendix B. VI Utilization Space Standard.

Order 4420.4, Appendix 1 can be used as a historical guideline, but it is not enforceable. This AMS standard applies to ATCT administration space per AMS Real Estate, Appendix B. VI. C. – “Operating Technical Space”; Administration Space. (AMS has superseded Order 4420.4, Space Standards (1983) per ASU-100.)

g. An example of an AMS administration area calculation using fictitious number of administration “staff of 30” on a single shift and a 4,500 SF administration area design:

1) Administration area including primary office and support space depicted on the “staff of 30” conceptual design = 4,500 SF.

2) Single Shift Staffing: Number of approved AT administration and AF administration staffing on the largest shift of 30 people.

3) Allowable administration primary office with support area = $(152.5 \text{ SF/person}) \times (\text{number of persons})$.

a) Allowable “staff of 30” primary office with support area = $152.5 \text{ SF/person} \times 30 \text{ persons} = 4,575 \text{ SF}$.

b) Comparison of designed area against allowed area: 4,500 SF Planned < 4,575 SF Allowed.

c) If the comparison has the planned less than or equal to the allowed, this is an acceptable area. If the comparison has the planned greater than the allowed, then redesign must be considered before going forward.

4) Administration primary office with support area with future expansion = $(152.5 \text{ SF/person}) \times (\text{number of persons}) \times 1.25$ (expansion factor).

a) “Staff of 30 plus 25%” = $(152.5 \text{ SF/person}) \times (30 \text{ persons}) \times 1.25$ (expansion factor) = 5,718.75 SF.

h. Other Room Areas. Define all spaces associated with the facility design and the existing facility spaces. List space that was leased in the former facility. Also, provide an explanation of how the room/area supports ATC functions.

TABLE 5-5. EXISTING AREA COMPARISON TO PROPOSED AREA

Room	Existing Area	Proposed Area
Computer-Based Instruction (CBI)	0	
Contractor Rooms	0	
Debrief Room	0	
Drug Testing Room used for mandatory drug test sampling	120 SF	125 SF
Electronic Equipment Rooms	600 SF	600 SF
Environmental Support Unit (ESU)	300 SF	450 SF
Janitors Closet	25 SF	50 SF

Room	Existing Area	Proposed Area
Loading Dock	0	100 SF
Locker Room	200 SF	400 SF
Mail Room	0	25 SF
Mechanical Equipment Rooms	400 SF	400 SF
Quiet Room used for indoor smoking	96 SF	96 SF
Quality Assurance	0	
Copy/FAX Room	25 SF	50 SF
File Room	0	200 SF
Logistics	0	150 SF
Ready Room	0	
Shops	0	
Storage	0	
TELCO	18 SF	24 SF
TRACON Operations Room used for ATC	2,000 SF	3,000 SF
Training (based on Operations staff)	0	
Workrooms	0	

1) AT/AF Staffing Numbers. List the total approved staffing for AT and AF during the single largest shift for the existing facility and for the proposed facility. The single largest shift includes only the persons on that shift, without temporary overlapping staffing during shift changes. This includes administration and non-administration staffing.

a) List the number of AF in Equipment Rooms and ESU areas during the largest single shift.

b) List the number of AT staffing performing ATC on the single largest shift.

c) List the source of the individual requirements for space.

d) ATC Positions. List the number of approved ATC ATCT/TRACON equipped positions for the existing facility and for the proposed facility.

TABLE 5-6. QUANTITY OF ATCT/TRACON POSITIONS BY TYPE

ATCT Positions	Quantity
1. Flight Data	
2. Clearance Delivery	
3. Ground Control	
4. Local Control	
5. Assistant Local Control	
6. Supervisor	
TRACON Positions	Quantity
1. Flight Data	
2. Radar	
3. Handoff/Associate	
4. Coordinator	
5. Supervisor	

2) Joint Space. Co-located organizations shall combine similar use space as feasible; e.g., conference rooms, smoking rooms, break rooms, etc.

3) Design Submittals. Three copies of all design packages (half-size drawings, specifications, design data handbooks, and cost estimates) shall be sent to ATB-320. In addition, include three CD files of the final design package with the final design hardcopies. Plan for a three-week turnaround time from the day ATB-320 receives the design packages to the time that comments/approvals are provided back to the ICs. Send design submittals to:

FAA Terminal Facilities Business Service, ATB-320/(ATO)
Attention: Debbie Cole & Jonathan Dorfman
(c/o Carl Lyons or Dave Henderson)
800 Independence Ave., SW
Washington, DC 20591

4) Construction funding will not be issued until ATB-300 concurs with the final design.

5) Requirements Development. The requirements team shall analyze space requirements and sizes of both administration areas and non-administration areas. A determination will be made as to the classification of quiet rooms, wellness rooms, certain types of storage rooms, etc., and if these areas relate directly or indirectly to technical space as well as the relationship to

AMS administration space guidance.

117. SIZE AND SHAPE. size of the various administrative spaces shall be as indicated in FAST. The space shall be designed to provide usable areas for the intended space function. Consideration should be given to additional administrative space requirements based on special functional requirements; i.e., hub facility designator. Orientation, shape, and geometry of the facility or rooms shall be determined during conceptual design. Consideration of real estate available may impact the size and shape of the facility.

a. Interior Finishes.

1) The ceiling areas shall be accessible acoustical ceiling tile with a high noise reduction coefficient. Acoustical sound blankets shall be placed above the ceiling tile to limit noise transmission.

2) The walls should be constructed as sound attenuated ceiling-high partitions utilizing pre-finished, low maintenance wallboard or plaster finishes.

3) The walls may be gypsum wallboard, plaster, masonry, or movable demountable partitions.

4) The walls shall have a 4-inch high base and the floor covering shall be carpet or vinyl composition.

5) Wall design should allow for the future removal and relocation of all non-load bearing or non fire-rated interior walls with minimum disruption and cost.

b. Functional Requirements. Administrative areas shall provide space for appropriate AT and AF management and administrative personnel as justified and/or authorized to meet facility requirements.

118. TRAINING AND CONFERENCE ROOMS.

a. Description. These training and conference rooms provide joint use areas in which AT and AF personnel conduct conferences, briefings, and training.

1) When the SF of a conference/training room is 240 SF or more, the room should be divided by a movable type partition.

a) Movable type partitions should recess into wall or fold out of the workspace.

b) The partition shall have low sound transmission characteristics, and a gypsum board closure shall extend from the finished ceiling above the partition to the underside of the deck above.

2) Controllable natural window light is desirable.

3) The training rooms shall meet FED-STD-795 requirements.

b. Size and Shape. The size of the conference/training room shall be determined by FAST standards. The shape shall be appropriate for the furniture and function that the room will serve.

c. Interior Finishes.

1) The ceiling areas shall be accessible acoustical ceiling tile with a high noise reduction coefficient. Acoustical sound blankets shall be placed above the ceiling tile to limit noise transmission.

2) The walls should be constructed as sound attenuated ceiling-high partitions utilizing pre-finished, low maintenance wallboard or plaster finishes.

3) The walls may be gypsum wallboard, plaster, masonry, or movable demountable partitions.

4) The walls shall have a 4-inch-high base and the floor covering shall be carpet or vinyl composition.

5) Wall design should allow for the future removal and relocation of all non-load bearing or non fire-rated interior walls with minimum disruption and cost.

6) Floor coverings may be carpet designed for high traffic usage with a high degree of static dissipation, installed with cove base around the room perimeter.

7) Avoid wallpaper use with complicated patterns that are difficult to install.

d. Special Equipment. A whiteboard and roll-up projection screen shall be provided for each divisible space over 200 SF. The size of this equipment shall be appropriate for the room size and function.

119. BREAK ROOMS.

a. Description. Break rooms provide space for AT and AF personnel to prepare and eat meals and for on-duty break periods. The equipment within this space should be adequate for preparation of simple snacks, packaged meals, or hot drinks. This area shall be within close proximity to the cab in ATCT facilities and the TRACON in the ATCT/TRACON facilities.

1) Only one break room is required for base buildings.

2) It is desirable to locate the break room so that protected outdoor eating areas can be utilized.

3) Controllable natural light is desirable for the space.

4) Avoid designs and materials that take on the appearance of an office, or elements that look busy.

5) The break room should be designed in accordance with FED-STD-795.

b. Size and Shape.

1) The number of people using the space determines the size. The break room space requirement is 12 to 15 SF per occupant.

2) The shape or layout of the space should separate the area of food vending from the lounge area.

c. Interior Finishes.

1) The ceiling areas shall be accessible acoustical ceiling tile with a high degree of noise abatement properties. Acoustical sound blankets shall be placed above the ceiling tile to limit noise transmission.

2) Floor coverings may be carpet that is easily cleaned and designed for high traffic usage.

3) The walls should be constructed as sound attenuated ceiling-high partitions utilizing pre-finished, low maintenance wall board or plaster with vinyl or washable finishes.

4) The walls may be gypsum wallboard, plaster, masonry, or movable demountable partitions.

5) The walls shall have a 4-inch-high base and the floor covering shall be carpet or vinyl composition.

6) Wall design should allow for the future removal and relocation of all non-load bearing or non fire-rated interior walls with a minimum of disruption and cost.

7) Avoid wallpaper with complicated patterns that are difficult to install.

8) Emphasis should be placed on ease of cleaning the eating and cooking area wall and floor surfaces.

d. Special Equipment.

1) Cooking.

a) Provide the space with a counter (5-foot minimum length), cabinets with 20 cubic feet minimum storage space, a microwave oven, chilled water dispenser, hot water, sink with garbage disposal, and an appropriately sized refrigerator.

b) Cooking equipment provided shall be protected in accordance with NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Equipment.

2) Equipment.

a) The number of kitchen appliances provided should be based on the facility size.

b) There shall be a tack board, 8 SF minimum, near the entrance to the space or within the space.

c) Installed appliances should have Energy Star rating.

3) Outlets. An electrical convenience outlet shall be provided in the lounge area.

4) Lighting. Lighting should be fluorescent; however, natural lighting should be provided to the maximum extent possible.

e. Fire Extinguisher. A fire extinguisher that meets FAA-STD-004 shall be located near each cooking unit throughout the facility.

120. LOCKER ROOMS.

a. Description. The locker room provides a space for AT or AF personnel to secure their personal belongings while they are on duty or a place to store work equipment while they are off duty. All facets of locker rooms shall comply with FED-STD-795.

1) Locker rooms should not be part of the break rooms or other administrative or functional space and should be near the TRACON room in combined facilities.

b. Size and Shape.

1) The number of personnel requiring lockers will determine locker room size.

2) The size is dependent on the number of lockers required for the facility.

3) The space is normally 8 feet or 16 feet wide, with the length determined by the number of lockers required for the facility personnel.

4) Lockers are placed in rows, parallel to the length of the room, and leave at least 4-foot wide aisles.

c. Interior Finishes.

1) The ceiling shall be accessible acoustical ceiling tile in finished space areas.

2) The walls may be gypsum wallboard, plaster, masonry, or movable demountable partitions.

3) The walls shall have a 4-inch-high base, and the floor covering shall be carpet or vinyl composition. See paragraph 112.e.5).

d. Special Equipment.

1) Personal lockers shall be provided for all AT and AF personnel in the facility.

2) As a minimum, 15-inch wide by 72-inch high double lockers with separate coat

compartments, and upper small compartments should be provided.

- 3) It shall be possible to lock all compartments.
- 4) Small compartment doors should have venting slots large enough to accept mail.
- 5) The locker installation shall be designed not to collect material on the locker tops and be within normal reach.

121. TOILET ROOMS.

a. Description. Provide toilets adjacent to personnel occupied areas in accordance with OSHA requirements.

1) A single toilet may be provided for occupancies of ten or less, such as toilet rooms serving ATCT cabs. Otherwise, separate male/female toilet rooms shall be provided in accordance with the International Plumbing Code (IPC).

2) Where there are TRACON operations rooms in facilities, the toilet rooms shall be located nearby.

3) A toilet room shall be located on the junction level or subjunction level below the cab in all towers.

4) Refer to CHAPTER 8, PLUMBING DESIGN, paragraph 258.

b. Size and Shape. Toilet rooms shall be sized in accordance with FED-STD-795.

1) The shape and layout of the room shall provide visual privacy from corridors, shall accommodate a wheel chair, and shall be equipped with disabled access fixtures.

2) Toilet rooms serving only the control cab and cab-related adjacent spaces are not required to be accessible to the disabled.

3) If a rest area is not provided elsewhere within the facility, there shall be one located in the women's toilet. See paragraph 105 for disabled provisions.

c. Interior Finishes.

1) The ceiling shall be suspended, water-resistive gypsum board or plaster.

2) The walls shall be painted masonry, gypsum wallboard, or plaster.

3) The walls may also be, and the floors shall be finished with ceramic tile. Care shall be taken to have a smooth transition from ceramic to adjacent floor areas.

d. Special Equipment.

1) Provide toilet partitions, accessories, mirrors, grab bars, soap dispensers and paper

towel dispensers, waste receptacles, sanitary napkin and tampon disposal containers (for women's toilets), coat hooks, etc., as required.

2) In each disabled access toilet room, provide one disabled toilet stall and at least one disabled access lavatory in accordance with FED-STD-795.

3) Toilet room and plumbing fixtures shall be purchased in accordance with EPA CPG program under the RCRA procurement requirements. Information is available at the EPA web site (<http://www.epa.gov>).

e. Shower Room. Shower and change areas for men and women shall be provided in an appropriate area of the facility and may be a part of rest or locker rooms.

122. TRACON OPERATION ROOM AND SIMULATOR ROOM.

a. Description. The TRACON operation room contains radar displays and instrument consoles used to control air traffic. This room is optimally located in a one- or two-story base building adjacent to the tower. Operational space shall be determined by the number of existing and future operational positions planned and shall include provisions for on-the-job training requirements.

b. Size and Shape. The TRACON operation room size is determined by the total radar display consoles used or planned for the room.

1) A minimum 8 foot clearance shall be provided behind the radar displays for display pullback and maintenance.

2) Console bays configured in a facing layout (see Appendix 3 Figure 15) shall be separated by 16 feet.

c. Interior Finishes.

1) All TRACON interior architectural exposed surface treatments shall be non-glare and non-reflective finishes.

2) The ceiling shall be accessible acoustical ceiling tile with low light reflectance. Darker colored ceiling tiles with textured surfaces, high acoustics damping, and low reflection properties are preferred. Recommended ceiling tile colors range from a flat black to a lighter gray/blue surface. Gray or off-white surfaces are reflective and produce less glare on the radar displays than white/lighter ceiling tiles. In some situations, black ceiling tiles may not be as desirable when using the ceiling as a reflective surface.

3) The walls shall be acoustically treated with soundboard or similar material and fire rated to meet local codes.

4) The total room shall be acoustically treated to provide a 50-decibel noise reduction in the speech frequency range.

5) The floor shall be carpeted with a high-density, high traffic, commercial grade, low electrostatic discharge low-level cut pile carpet or carpet tile that will enable chairs to roll easily. See paragraph 112.e.8) for specific carpet electrostatic discharge requirements.

6) Door openings to lighted adjacent spaces shall be screened so light will not flood the space when doors are opened. Doors shall be provided with floor sweeps and/or weather stripping to eliminate light glare under doors or between joint openings, where necessary.

7) Exit lighting in the TRACON operations room shall be screened so the lighting will not reflect or cause glare on operational positions. Exit lighting designs should use LED non-glare, low energy and low maintenance devices or other state-of-the-art lighting products.

d. Simulator Room. This is an area similar to the TRACON operations room, which may be required for training controllers in a simulated TRACON environment. This room should be located adjacent to or below the radar equipment room if critical cable length requirements are an issue.

e. Raised Floors. Raised access flooring shall be considered in all TRACON operational areas in accordance with paragraph 114 requirements.

123. COMMUNICATIONS EQUIPMENT ROOM.

a. Description. This space contains the electronic equipment and racks necessary to provide radio communication, instrument landing system (ILS) monitors, and recorders.

1) The preferred location is in the base building adjacent to the TRACON room.

2) This room may be co-located in a space with radar or other equipment if space utilization warrants.

3) At low activity level facilities, radar automation radar, communications, and NAVAID equipment co-location is preferred.

4) Refer to Appendix 3, Figures 12 and 13 for typical or representative room equipment and layouts.

b. Size and Shape. The equipment racks required for the facility activity level determine the room size.

1) The standard FAA equipment racks are approximately 22 inches by 22 inches by 84 inches high and can be positioned adjacent to one another to form rows.

2) Communication/automation equipment racks vary in size and are usually larger, such as 24 inches by 28 inches by 72 inches.

3) Refer to Appendix 3, Figure 14, for minimum clearance dimensions and layout.

4) Space shall also be provided to accommodate a workbench, test equipment, and

storage cabinets.

5) If a ceiling is installed, the enclosed space shall be fully reachable by capable personnel; however, exposed ceilings are preferred.

c. Interior Finishes. The ceiling, if exposed construction, should be painted a light color.

1) The walls shall be gypsum wallboard, masonry, or concrete.

2) The walls shall have a 4-inch high base and be not less than one-hour fire rated.

3) The floor covering shall be a light color vinyl composition floor tile.

4) See paragraph 112.e.8) for additional floor covering requirements.

d. Raised Floors. Raised access flooring shall be designed into all new equipment areas in accordance with paragraph 114 requirements.

124. RADAR AND ELECTRONIC EQUIPMENT ROOM.

a. Description. Radar equipment rooms shall be located in the base building adjacent to the TRACON room.

1) The room contains the equipment racks and auxiliary components necessary for air traffic radar surveillance and/or ARTS and STARS control.

2) A separate acoustically treated room shall also provide space for equipment maintenance and related equipment storage.

3) Refer to Appendix 3, Figures 10 through 13 for typical or representative room equipment and layouts.

b. Size and Shape. The room size is determined by the equipment size, number of systems, and the total components required for the activity level.

1) Certain equipment racks can be positioned adjacent to one another to form rows.

2) Refer to Appendix 3, Figures 10 through 13, for minimum clearance dimensions and layouts.

3) Provide space for a workbench, test equipment, and storage cabinets.

c. Interior Finishes.

1) The ceiling may be suspended acoustical ceiling tile for noise control.

2) The walls should be gypsum wallboard, masonry, or concrete.

3) The walls should have a 4-inch high base and not be less than one-hour fire rated.

4) The floor covering shall be a light color vinyl composition tile or low electrostatic discharge carpet. See paragraph 112e for additional floor covering electrostatic discharge requirements.

d. Combination Communication and Radar Equipment Room. Where feasible, it is desirable to combine communication and radar equipment rooms or have them adjacent.

e. Raised Floor. Raised access flooring shall be designed into all equipment areas in accordance with paragraph 114 requirements (see paragraph 300b2h)).

125. STORAGE.

a. Separate dedicated storage areas shall be provided for administrative and electrical/mechanical supplies.

b. Storage space shall be adequate to meet the facility mission needs for spare parts; handbooks; technical documentation; test equipment; and administrative, mechanical, and electrical supplies.

126. RECORDER PLAYBACK ROOM.

a. Description. This room contains recorder playback equipment. The room is used by personnel to listen to recorded conversations between controllers and pilots.

1) The equipment required for this operation may be portable and set up for operation within existing assigned spaces, or when required, a dedicated room will function as a recorder playback room.

2) There shall be a tape storage unit, chairs, counter or table for writing, and the playback equipment within the space.

3) A dedicated room is not required in all facilities. In those facilities when a dedicated room is required, it shall be a minimum 80 SF.

b. Size and Shape. The room shall be located in a facility secure area and shall provide space adequate to house the equipment supporting the intended function. The shape is determined by the equipment location and room arrangement.

1) The ceiling height shall be eight feet minimum.

c. Interior Finishes.

1) The ceiling shall be constructed from accessible acoustical ceiling tile.

2) The walls shall be gypsum wallboard, masonry, or concrete.

3) The room should be acoustically treated to eliminate background noise.

- 4) The walls shall have a 4-inch-high base, and the floor shall be carpeted.

127. TELCO ROOM.

a. Description. This room contains the leased service carrier equipment that terminates leased voice and data telecommunications circuits required for ATC services. This operational telephone equipment is separate and in addition to the administrative area telephone equipment.

b. Where indicated by FAA Order 6000.36, Communications Diversity, and the specific telecommunications network design, the facility property layout design should include a telecommunications utility diagram that allows no common cable points except within the telco room.

c. The telco room may be located in the tower shaft or in the base building. However, it should be adjacent to the electronic equipment rooms in either case.

d. Telco rooms that shall be accessed and serviced by non-FAA personnel shall be accessed externally with secured internal access to other FAA facility space.

e. Size and Shape. The telco room shall be sized to meet space requirement for equipment to be provided and maintained by telephone companies.

- 1) The equipment racks layout should be coordinated with the telephone company.
- 2) The clear ceiling height shall be nine feet minimum.
- 3) Space shall be provided for a minimum 2-foot by 4-foot work counter.

f. Interior Finishes.

- 1) The ceiling shall be exposed construction painted white or a light color.
- 2) The walls shall be gypsum wallboard, plaster, masonry, or concrete. The walls shall have a 4-inch high base and the floor shall be a light color vinyl composition or concrete with a hardener.
- 3) One wall shall have a 3/4-inch plywood panel of sufficient size (as designated by the telephone company) for the installation of demarcation panels.
- 4) See paragraph 112.e.8) for floor covering requirements.

g. Raised Access Floors. Raised access flooring shall be considered when it can be shown to be cost effective by reducing or eliminating the cost of cable trays, duct work, etc. When the need for a raised floor is determined, it shall be installed in accordance with paragraph 114 requirements.

128. ENGINE GENERATOR (E/G) SPACE. An E/G set shall be provided in accordance with Order 6030.20, Electrical Power Policy and Order 6950.2, Electrical Power Policy Implementation at National Airspace Systems Facilities.

a. The E/G and associated components may be installed individually in a specially designed building, or the E/G set may be procured as a packaged system (all associated components already installed) in a weatherproof building.

b. The E/G building or the packaged E/G system shall always be located at ground level and shall be located in accordance with the guidance provided in CHAPTER 5, Section 7, Space Relationships. Regardless of the configuration selected, adequate maintenance space shall be provided and this space should be protected from climatic exposure.

c. When a dedicated E/G building is selected, the equipment located in the UPS equipment room (paragraph 129) and in the mechanical equipment room (paragraph 130) may be co-located in this building. Where co-location is desired, the E/G building shall meet the combined facility design paragraph 231,k, l, and p requirements.

d. The E/G space shall have an isolated structural equipment pad. The pad shall be designed to prevent vibration transmission to the surrounding floor structure.

e. Typical installations have the E/G separately housed, but installation within the facility building is permitted when cost effective and all installation requirements are met.

f. E/G battery systems shall be installed in accordance with 29 CFR 1926.441.

g. Refer to CHAPTER 9, paragraph 288, for E/G sizing and associated components, which may be installed individually in a specially designed building, or the E/G set may be procured as a packaged system (all associated components already installed) in a weatherproof enclosure.

h. The packaged E/G system is the preferred configuration; however, it shall only be installed when the overall life-cycle cost is less than or equal to that for installing an E/G set (with individual components) in a dedicated and specially designed building.

i. Where a spark-ignited E/G is installed, the muffler and radiator shall be purchased with waste heat recovery (water jacket loop) adaptability to provide supplemental heat for the ATCT/TRACON facilities as appropriate.

j. Installation of the E/G set shall comply with all EPA regulations. Refer to CHAPTER 9, ELECTRICAL DESIGN, paragraph 288, for E/G set sizing.

1) Engine Generator Building.

2) Description. Where activity levels justify the need, a separate building to house the E/G should be constructed. Refer to paragraph 231.k for additional E/G building requirements.

3) Size and Shape. The designer shall determine the size, shape, and location of the building in coordination with the designated approval authority.

- a) Adequate access space for maintenance shall be provided.
 - b) The early determination as to whether this building will house other mechanical equipment is critical to this exercise.
- k. Ventilation.
- 1) Provide storm-proof air intake and exhaust louvers with automatic damper control.
 - 2) Exhaust from the E/G shall be handled in accordance with local and national codes.
 - 3) Care shall be taken to ensure that engine exhaust is kept away from building fresh air intakes.
 - 4) All louver and exhaust fan openings in excess of 96 square inches shall be burglarproof construction.
 - 5) Ventilation openings shall be sized to provide adequate E/G cooling and combustion air, in addition to any room ventilation requirements.
 - 6) When a spark-ignited E/G is installed, a propane or natural gas purge capability and personnel propane and natural gas leak warning detector shall be provided with outside annunciation. The purge capability may be accomplished by installing a squirrel cage blower (50 CFM minimum) with a 2-inch (minimum) intake/discharge. The purge motor shall be installed six feet above the floor with and connected to a 2-inch (minimum) PVC pipe with inlet located six inches above the floor for propane and six inches below the ceiling for natural gas. The motor shall be continuous running, connected to essential power, and shall discharge to the exterior of the building away from ventilation system intakes. Fans shall be installed in accordance with NFPA 58, LP Gas Code. See paragraph 269 for additional fuel storage requirements.
 - 7) A wall may be installed in front of the ventilation openings that are subjected to high winds to reduce positive pressure on the openings when local conditions warrant.
- a) Construction Considerations.
- (1) The fire rating for walls and doors shall conform to local and national codes. However, if the E/G building is in physical contact with the ATCT/TRACON building, the interior wall and door construction shall have a fire rating of not less than two hours.
 - (2) The design shall provide plant and vibration noise attenuation by using sound absorption construction materials, such as sound absorptive masonry block or concrete walls. Doors shall be sound insulated and weather-stripped to prevent noise and fumes from entering adjacent spaces.
 - (3) Provide metal doors or removable wall panels with a minimum opening of 5 feet by 7 feet to the exterior. A cold water tap and a floor drain shall be provided within the space.

(4) Provide outside space adjacent to the E/G building for an above ground fuel tank with a minimum storage capacity in accordance with Order 6950.2. Fuel tank installation and supply lines shall comply with NFPA 58, Order 1050.15, OSHA and local regulations. Propane vapor pressure entering the building shall be less than 20 psi.

(5) Provide raceway from electrical service to E/G space.

(6) Outdoor space shall be provided, adjacent to the building, for a remote radiator, when required.

(7) The E/G structural pad shall be isolated from the surrounding floor structure.

(8) For diesel powered E/Gs, a containment means shall be designed to control fuel or oil spills.

(9) Further means shall be provided for the proper handling of any hazardous materials to provide minimum hazard to personnel.

l. Interior Finishes. The ceiling shall be exposed construction and should be painted a light color such as white. The walls shall be sound absorbing masonry block or concrete. The floor shall be concrete with a concrete sealer applied.

m. Other Construction Considerations. If the E/G assembly is located in an area that is physically attached to the ATCT/TRACON building, the interior wall construction shall have a fire rating of not less than two hours. Provide 2-hour fire rated metal doors or removable exterior wall panels with a minimum opening of 5 feet by 7 feet.

1) Provide outside space for an above or below ground propane or diesel fuel tank with a minimum storage capacity of 72-hour continuous operation. Installation of natural gas lines, liquid propane fuel tank, and supply lines shall comply with Order AF P 6980.3, Plant Equipment Modification Handbook - E/Gs with changes 289 and 305, and local restrictions. See paragraph 269 for fuel storage tank requirements.

2) Provide raceway from electrical service to E/G.

3) Engine Generator System (Packaged).

a) Description. A packaged emergency power E/G system should be installed where it is cost effective to do so (see paragraph 128 above). This assembly is a self-contained unit housed in a weatherproof enclosure (suitable for outdoor installation) and designed for sound attenuation. It comes equipped with all required monitoring/control and ventilation/cooling features. When the E/G system is providing fire protection and life safety system emergency power, the systems shall be installed in accordance with NFPA 37 and NFPA 110.

b) The pre-packaged E/G assembly comes complete with E/G, batteries, open or closed transition transfer switches, internal muffler, generator circuit breaker, temperature controls and alarms, RMM sensors and alarms, equipped for remote or local controls, ready to be bolted to a zone 3 seismically designed vibration isolation pad with 480 volt, 3 phase, wye, 3

wire, power connections.

c) The generator neutral is grounded to a ground bus for connection to building counterpoise, internal lightning, and surge protection in accordance with FAA-STD-019 and the NEC requirements.

d) The E/G set is ready for connection to diesel, natural gas, or liquid propane fuel source with proper pipe size and fuel pressure. The E/G will be pre-tested and ready to operate. Fuel leak detector and ventilation exhaust shall be provided in accordance with LP or natural gas E/G installation. With this prepackaged assembly, there is little concern for special design features for dedicated E/G building.

e) If the E/G is housed in a building, maintain the internal building temperature between 55°F and 85°F. The engine oil and radiator water will be maintained in a preheated condition for fast emergency power operation, as required in the prepackaged design.

f) A high volume, rail mounted, radiator fan is required for simultaneous operation with and by the E/G set. This fan is sized by the manufacturer to draw air through the E/G assembly at a rate sufficient to remove radiator, engine, and generator radiated heat.

g) The air intake for the E/G assembly should be via a filtered, storm proof outdoor air louver with multi-blade (sectioned) low-leakage, motorized control dampers.

h) Size and Location. The designer shall determine the size and location of the E/G assembly in coordination with the designated approval authority. Easy access for maintenance shall be provided.

n. Ventilation. The packaged E/G system comes equipped with necessary ventilation openings. However, when a spark-ignited E/G is installed, it shall come complete with a leak detector and natural gas/liquid propane purge capability to expel any gas leakage. The purge motor shall operate upon gas leak detection, be connected to essential power, and shall discharge to the exterior of the building away from ventilation system intakes. Exhaust from the E/G shall be handled in accordance with local and national codes. Care shall be taken to be sure that engine exhaust is kept away from fresh air intakes.

129. UPS EQUIPMENT ROOM. A separate room should be provided for UPS equipment and batteries, at locations where they are required. Adequate air conditioning and ventilation shall be provided where separate UPS and battery rooms are used. To provide minimum hazard to personnel, where appropriate, further means shall be provided for the proper hazardous material handling.

a. The UPS equipment installation shall generate minimum harmonic distortion and shall conform to the “power distribution to electronic equipment” IEEE-STD-1100, Recommended Electronic Equipment Grounding Practice guidelines and the Federal Information Processing Standard (FIPS) publications.

b. See paragraph 288b for additional UPS equipment requirements.

c. The UPS batteries shall be installed in accordance with NEC and OSHA safety requirements.

130. MECHANICAL EQUIPMENT ROOMS.

a. Description. These areas will house the basic operating elements of mechanical and electrical equipment not located elsewhere. These spaces are usually required in the shaft structure and base building. There are two space types that house mechanical equipment.

1) Fan Room. A fan room is defined as a space where predominately only air handling equipment, with their controls and other equipment (but there is no open flame equipment, such as a boiler, gas fired furnaces, gas fired water heaters, E/Gs, etc.) are installed.

2) Mechanical Room. A mechanical room is defined as a space where all of the items listed for a fan room may be present, including open flame equipment (such as a boiler, gas fired furnaces, gas fired water heaters, E/Gs, etc.). The mechanical room should be located near the electrical service and the E/G set.

a) Mechanical room and fan rooms should be designed with maintainability as a prime consideration. Equipment manufacturer recommendations on access to equipment shall be followed.

b) Outside access panels should be large enough to allow use of mobile or portable cranes, and large mechanical equipment should be located near exterior access panels.

c) The space shall accommodate a 2 foot, 6 inch by 4-foot minimum workbench for maintenance work purposes.

d) Size and Shape. The mechanical room size is determined by the equipment amount and size to be housed.

b. Construction Considerations. Interior wall and door construction shall have a fire rating of not less than two hours for mechanical rooms and not less than one hour for fan rooms.

1) The design shall consider attenuation of noise and vibration where applicable to the type of equipment used for the mechanical system. Provide doors or removable panels to the exterior for removal of equipment.

2) Provide interior access to the corridor system. Electrical distribution panels and switchgear should be located in the mechanical equipment room space. Noise isolation and weather-stripping interior doors are required.

a) Provide hot and cold water taps and floor drains within the space.

b) Roof top installations should be avoided; however, if the particular facility design warrants, mechanical equipment may be placed on the roof.

c. Interior Finishes.

- 1) The ceiling shall be exposed construction and should be painted a light color such as white.
- 2) The walls should be masonry, concrete, metal panel, or steel stud partitions with waterproof and fire retardant wall panels.
- 3) The floor shall be concrete with a concrete sealer applied.

131. RECEIVING AREA. Provide a facility receiving and loading area with an overhead door or double doors opening into an area for unloading trucks. It does not normally have to accommodate a semi-trailer. The size should be dependent on the level of activity and type of equipment at the facility.

132. MECHANICAL/ELECTRICAL MAINTENANCE SPACE.

a. Description. This area should provide a common space for electrical and mechanical maintenance personnel.

- 1) The space shall be proximate to the E/G set, the ECMS/DDCS (see paragraph 242.k), and mechanical/electrical room but acoustically separate.
- 2) A workbench, test equipment, personnel lockers for the required personnel, service sink, and minimum parts and tool storage are contained within this space.
- 3) Provide storage space for electrical or mechanical maintenance equipment adjacent to or in these rooms where possible.
- 4) Provide convenience outlets on a separate circuit located 48 inches above the floor.
- 5) Provide fresh air access and access to facility HVAC.

b. Size and Shape. The space size is dictated by the amount and type of facility equipment provided and maintenance personnel both local and remote based at the facility. The ceiling height shall provide a minimum of 9 feet of clear space above the floor level.

c. Interior Finishes. The ceiling shall be exposed construction painted white. The walls shall be masonry, concrete or metal panel construction. The floor shall be concrete with concrete sealer applied.

133. JANITOR CLOSET.

a. Description. This area is used to store janitorial equipment and supplies for the buildings and grounds.

- 1) Space shall contain storage racks, shelves, cabinets, mop rack, and janitor's sink.
- 2) Provide convenience outlets, hot and cold water, heating, and ventilation for this area.

b. Size and Shape. The size is or sizes are, if the janitor rooms are separated, dictated by the equipment to be stored and the lavatory areas.

- 1) The janitor rooms shall be in the vicinity of the mechanical space or lavatories.
- 2) The room shall provide sufficient space for including OSHA-required containment areas for storing hazardous cleaning chemicals.
- 3) The room size should be 30 SF; however, the minimum shall not be less than 20 SF.
- 4) When located adjacent to lavatories, the space may contain a small, fast recovery hot water heater for the lavatories.

c. Interior Finishes.

- 1) Ceiling finish may be exposed construction.
- 2) Walls may be gypsum wallboard, masonry, or concrete.
- 3) The floor may be concrete or tile.
- 4) Walls and doors shall be one-hour fire rated.

134. CORRIDOR LINK.

a. Description. These specially constructed corridors provide weatherproof access between adjacent ATCT and TRACON structures and shall be readily adaptable as an employee entrance to the facility. The design of the link should allow for tower and base building structures differential settlement without floor or walls cracking.

b. Size and Shape. Size and shape are variable and dependent upon ATCT/TRACON design and placement on the site.

- 1) Standardized link designs should allow for flexible orientation of the tower shaft in relation to the base building for optimum cab orientation.
- 2) The link shall be designed with adequate space for overhead or under-floor cable trays, as appropriate.

c. Interior Finishes. Finish may be exposed construction, exterior glass or gypsum board walls, acoustical ceiling, and vinyl composition tile or clay tile floors.

d. Special Considerations. A combination of three access control techniques (cipher, lock switch, and telephone or intercom) shall be provided at all ATCT/TRACON main entrances and at public and employee entrances in accordance with paragraph 24 security requirements. Access techniques shall meet FED-STD-795 requirements.

135. SMOKING AREA. Designation of smoking areas shall be in accordance with federal guidelines and employee union contract agreements. Smoking shall not be allowed where any smoke being generated will be introduced into the building ventilation system intakes.

SECTION 5. TOWER SHAFT REQUIREMENTS

136. GENERAL. This section states the requirements that are unique to tower shafts. The preferred ATCT design is a non-functional tower shaft with a base building.

137. DESCRIPTION. The tower shaft serves as a supporting structure for the control cab, as well as an enclosure for various cable runs, piping, stairway, junction levels, mechanical/electrical equipment, electronic equipment, storage, and elevator for all ATCT operations levels.

138. BASE LEVEL. The tower shaft base level contains the elevator lobby, stairway, stair vestibules, elevator (where applicable), storage or mechanical space, fire pump room, and cable and pipe chases.

139. TOWER SHAFT. Elevators and stairways shall be provided to connect the ground level with all other levels of the shaft.

140. CABLE/UTILITY CHASE. Cable chase space shall be provided for all levels of operation and comply with 29 CFR 1960.20.

- a. The chase space is normally a vertical space from the base level to the junction level terminating at the cab floor.
- b. The chase shall be accessible from the outside via below grade conduit.
- c. The size of the chase varies according to facility needs; however, the same capacity cable trays or conduits should go all the way from the tower shaft into the equipment room.
- d. The shafts and chases shall be non-combustion construction in accordance with 29 CFR 1960.20.
- e. The access spacing to the chase space should not exceed 20 feet throughout the tower shaft height.
- f. When the electrical or mechanical chase requirements require space that would enable a person to stand in the chase, the chase shall have steel floor grating at each floor level.
- g. Chase walls should be equipped with mounting hardware for cable trays, piping, conduit, etc.
- h. Refer to CHAPTER 9, ELECTRICAL DESIGN for spacing mechanical, control, power, grounding, and lightning protection.

i. Lightning down conductors shall not be located inside the utility chase and shall be insulated from the chase.

j. Chase and cable tray routing should consider direct paths between the ATCT cab and equipment rooms.

141. RESERVED.

142. JUNCTION AND SUBJUNCTION LEVEL. The floor level below the cab is commonly called the junction level, and the level below the junction level is called the subjunction level. Additional levels below the subjunction level may be justified due to the requirements for additional equipment. If windows are present on any of these levels, a window washing means shall be provided.

a. The junction level usually houses the cab mechanical equipment, elevator equipment, lavatory, and other spaces as required by the design.

b. The subjunction level usually houses the top elevator landing lobby, electronic equipment room, HVAC equipment, isolation transformers with special cab ground grid and electrical power panels, lavatory, and other spaces, as required. Only one lavatory is required on either level.

c. Two lavatories are required for ATCTs with cab areas over 600 SF.

d. Equipment rack space for airport surface detection equipment (ASDE), Low Density Radio Communications Link (LDRCL), and television microwave link (TML) may be located on either level.

143. INTERMEDIATE LEVELS. Incremental floors between the base level and subjunction level are commonly referred to as intermediate levels. The main purpose of these floor levels is to add height to the tower shaft. Additionally, these levels provide access to the utility shafts and the elevator shaft at the various elevations of the tower. The preferred ATCT design is a non-functional shaft.

144. RESERVED.

SECTION 6. CONTROL CAB REQUIREMENTS

145. GENERAL. This section states requirements unique to ATCT control cabs.

146. DESCRIPTION. The control cab serves as a vantage point from which the air traffic controller may have an unobstructed view of air traffic patterns around the airport, all operational movement areas of ground traffic, and permits a good visual depth perception at the extreme runway and taxiway end. Design considerations are based on the magnitude of activity, airport size, and configuration. Tower cab structural design, column, and window mullion location, shall minimize visual obstruction of all airport activity points.

147. SIZES AND SHAPE.

- a. The cab layouts shown in Appendix 3 are representative of towers with various levels of activity. Refer to Appendix 3, Figures 4 through 7 for low, intermediate, and major activity control cabs.
- b. Control cab shape is dependent upon the multiple windowpane angular placement to minimize adverse reflections on the glass.
- c. Positive tilt outward eliminates reflections from consoles and provides shading at high sun angles.
- d. Avoiding 90-degree corners minimizes reflections from external sources.
- e. Cab size is dependent on the number, location, and size of control positions and consoles.

148. FLOOR. The cab shall consider a raised floor installed in accordance with paragraph 114 requirements. There shall be two cable access methods from the raised floor to the 2-foot ceiling space located beneath the cab structural floor. The floor shall be carpeted within the cab operations area with high use, low electrostatic discharge (refer to paragraph 112.e.7) commercial grade carpet. The floor shall be a one-hour minimum fire resistant construction. Consideration should be given to the non-reflective rubber mat use in the operational area to reduce personnel foot fatigue. The rubber mat and all floor coverings shall conform to paragraph 112.e.8) static dissipation requirements. See paragraph 300 for signal reference grid requirements.

149. WALLS. The exposed cab walls above the window head and below the windowsill shall be a heavy-gauge insulated metal panel with noise absorbent backing. The finish of any interior exposed wall surface shall be a dark flat, non-reflective color. Charcoal gray has worked well; however, earth tone colors may also be considered. The exterior of the cab shall be finished with a dull dark colored exterior type paint, dark anodized aluminum panel, or pre-finished metal panel. The cab wall above the glass line shall be sloped in the same plane as the cab glass or at any angle less than that of the glass when measured from the vertical.

150. SILL. The cab windowsill shall be 29 inches above the cab floor. Refer to Appendix 3, Figure 17 for representative windowsill and wall section.

151. WINDOW GLASS. The cab glass design and installation shall provide maximum controller visibility and viewing area. The computer and radar displays in the tower cab must be available under different ambient light conditions. The maximum allowable tower cab ambient light shall be less than 6,000 fc. See paragraph 239 for additional cab window requirements.

- a. The glass shall slope outward 15 degrees from the vertical. Unless local design conditions; i.e., hurricane winds, or seismic considerations warrant otherwise, the windows shall be double pane, clear float glass, free of distortion.
- b. Tinted glass shall not be used since tinted glass may change the light gun color and reduce visibility in some conditions. Strong consideration should be given to the use of low E

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coated glass recognizing that the coating may reduce visible transmittance by approximately 5 percent.

c. The window unit size will determine the glass thickness. The minimum glass thickness shall be 1/4-inch with 1/2-inch air space between the glass units.

d. Window units should be constructed with a metal or composite plastic perimeter or unitized extruded aluminum system frame. The frame shall be bonded to the glass to provide an airtight, waterproof, and vapor proof seal.

e. The insulated glass unit may be hermetically sealed as described in sub-paragraph. High EMI environments may require EMI reflective glass.

f. Hermetically Sealed. These units shall contain a dehydrated sealed air space between the glass panes.

1) Within the bottom third of each unit, an open 12-inch stainless steel capillary/breather tube with an inside diameter of 0.021 inch shall be installed for drawing moisture out of air, while allowing pressure equalization at cab elevation. This tube shall be sealed when the window is installed.

2) The air space pressure shall be set at the tower location atmospheric pressure with the lights in parallel alignment (+ 1/64 inch).

3) Cab glass should be thoroughly tested for acceptable visibility, distortion, clarity, etc., prior to installation.

g. Unpressurized. Window units using light-gauge glass or resulting in a flexible assembly should be specified as unpressurized.

1) Unpressurized units are assembled the same as hermetically sealed units with the addition of a small breather portion to the air space on the inside face of the frame. The unit maintains atmospheric pressure under all conditions and lights remain parallel.

2) An accessible desiccant air filter canister shall be installed over the port to dry air entering the unit.

3) The canister design shall allow for periodic desiccant changing.

h. Security. See paragraphs 24 and 79, and Order 1600.69 for security requirements.

i. Computer and Radar Displays. The computer and radar displays in the tower cab must be available under different ambient light conditions. The maximum allowable tower cab ambient light shall be less than 6,000 fc.

152. WINDOW MULLIONS. To minimize visibility obstructions, the window mullions shall be designed with the minimum cross section required for glass and roof support and maximize outside viewing area.

- a. Maximum mullion width is 4-1/2 inches unless greater width is required to meet local design strength requirements; i.e., hurricane loading.
- b. Consideration shall be given to glass weight and wind loading requirements for the specific geographic location.
- c. The mullion and column finish and color shall be a non-reflective dark color. Charcoal gray and earth tone colors may also be considered.
- d. Consideration should be given to using butt glazing between sections in place of non-load bearing mullions.
- e. The design shall consider mullion access openings to facilitate cable and equipment maintenance.

153. CEILING. The minimum clear ceiling height from the cab floor to the ceiling shall be 10 feet. The ceiling may slope up at the outer area to enhance the controller's upward visibility from the opposite side of the cab.

- a. The ceiling shall be designed at the outer edges so that window shades and all fixtures as described in FAA-E-2470, Transparent Plastic Window Shades specification, may be installed.
- b. The minimum clear space from the ceiling to any supporting members above shall be 15 inches.
- c. The ceiling shall be removable acoustical panels, preferably 2 feet by 2 feet, and should be supported by a black, non-reflective suspended metal support grid.
- d. Provide two traffic signal lightgun mounting boxes.
 - 1) Provide a twist lock convenience outlet in the traffic signal lightgun mounting box. Portable light guns are allowed.
 - 2) The lightgun locations and detail shall be in accordance with FAA-E-2214, Gun, Signal Light, Portable and FAA-E-2229, Portable Signal Light Gun Reels specifications.
 - 3) There shall be no recessed lightgun mounting in the cab ceiling.
- e. Make provisions for mounting displays to the cab ceiling, where required. Displays may be fixed swivel mounted or suspended from a trolley and track arrangement.
- f. An electrical/mechanical method shall be designed to move and remove tower cab equipment. One point of the track should be located adjacent to the hoist.
- g. The cab ceiling shall be a non-reflective dark color. Charcoal gray has worked well; however, earth tone colors may also be considered.

154. ROOF. The preferred design shall incorporate a sloped roof. Attention should be paid to using the latest materials and technology to reduce maintenance requirements. The roof can be a single-ply, rubber membrane type or a built-up roof with insulation, to meet .05 “U” factor or a single membrane, or insulated roof membrane assembly (IRMA). The roof shall be designed to a 20-year serviceable life span.

a. A concealed telescoping type ladder shall be installed in the cab ceiling with a roof access hatch above to provide access to the roof from the cab operating floor.

b. Typically, antenna pipe mounts are welded to the top and bottom of the cab parapet tube steel.

c. There shall be a handrail mounted on the roof near the access hatch to aid personnel accessing the roof area.

d. The roof shall be sloped a minimum of 1/4 inch per foot to the drains.

e. The parapet may be built up to serve as the guardrail for the cab roof or a metal guardrail system may be installed. The guardrail height shall be 42 inches above the roof level.

f. Walkways shall be provided to all antennas and other serviceable equipment on the cab roof.

g. Walkways shall be designed to be permanent, and use compatible materials and construction methods to match the rest of the roof, and shall be in accordance with applicable OSHA requirements.

h. An antenna raceway is required around the perimeter of the cab roof to route cables to the communications antennas.

1) The antenna raceway shall provide a minimum 10 inches by 10 inches opening.

2) Feeder raceways with a minimum of 12 square inches inside area shall be provided to connect the cab column raceway to the antenna raceway.

3) Four (4)-inch by six (6)-inch access plates shall be provided on the opposite side or bottom of the antenna raceway at each feeder raceway entrance and each antenna or air terminal mount.

4) The antenna raceway shall be 3 feet 6 inches above the roof elevation.

i. If the roof parapet serves as a guardrail, a separate antenna raceway shall be provided. If a guardrail system is provided with no roof parapet, the antenna raceway may be incorporated into the top member of the guardrail or provided separately.

j. The maximum number of antenna mounts shall be furnished to provide for a nominal eight (8)-foot separation of the vertical communications antennas between each other and other vertical metal items such as air terminals. Antenna mounts shall be 2 1/2-inch pipe with 4 inches

exposed thread. Additional mounts may be installed for other types of antennas. Maximum communications antenna height shall be 15 feet above base.

k. The number of air terminals, location, and height shall be in accordance with paragraph 300.a.

l. When an Airport Surface Detection Equipment (ASDE) is expected to be installed, all new Intermediate Activity Level and Major Activity Level ATCTs control cabs shall be designed to support a penthouse (ASDE equipment) above the cab roof (ceiling).

- 1) Coordinate equipment room use to provide adequate ASDE equipment space.
- 2) Additionally, the penthouse roof shall support the ASDE antenna system.
- 3) The ASDE system consists of a radar antenna and an 18-foot diameter saucer-shaped plastic cover (rotodome) rotating on a four-legged mounting frame.
- 4) Intermediate base plates may be required for bolting the mounting frame to the cab structure (see Figure 5-1).
- 5) Access to the antenna is through the rotodome.
- 6) The antenna shall be high enough to see over the roof edge at an angle of minus 32 degrees with respect to horizontal.
- 7) For Special Design Loading, see paragraph 169.f. Avoid locating large objects in the path of the radar signal as this may have an adverse affect on system performance.
- 8) Most antennas and air terminals will not impact performance.
- 9) The design shall consider the impact of the ASDE rotodome on the directional performance of communications antennas located on the ATCT cab roof.

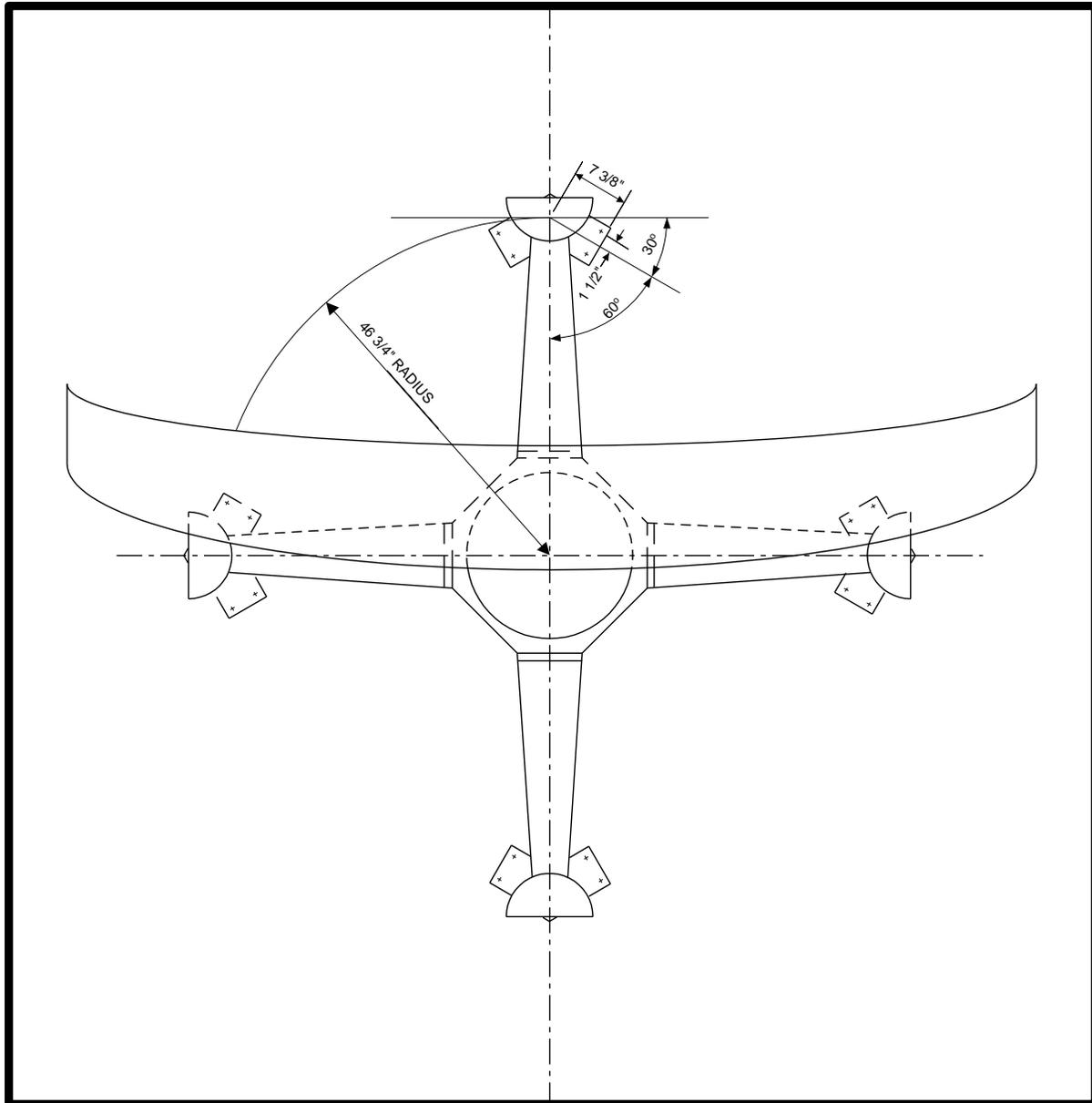


FIGURE 5-1 ASDE III ANTENNA BOLT HOLE LOCATION

m. Airport light beacons shall not be placed on the ATCT roof because the beacon's performance characteristics may inhibit the installation of certain other types of equipment and due to the noise and light reflections it can generate in the cab.

n. Obstruction lights shall be placed as required by FAA orders. Horizontal lifeline/fall protection may be required for outside obstruction light maintenance.

155. WALKWAY. A walkway shall be provided around the exterior of the control cab to facilitate washing cab windows.

a. The walkway shall be located at a sufficient elevation below the cab to permit the controllers a close-in view of the field unobstructed by any railing. The walkway should be at least 24 inches below but not greater than 48 inches below the cab floor level, shall be 3 feet wide, minimum, and include a toe board.

b. Provide weather-sealed access door from the stairway, or other accessible area, to the cab walkway. Head of door shall not extend above cab sill and the base of the door shall not extend below cab walkway elevation.

c. The design shall provide for a minimum 42-inch high handrail. If the cab has a center stairway, an access door to the walkway shall be provided below the windowsill through the cab wall.

d. Care shall be taken in the design to eliminate the possibility of snow or ice from dropping from the walkway to sidewalks below.

1) The railing shall be designed in accordance with applicable OSHA requirements.

2) The walkway surface should have a slip-resistant finish.

156. COLUMNS. The number of cab columns shall be kept to the minimum required to support the roof and glass.

a. The columns supporting the cab roof generally should not exceed 4 1/2 inches by 8 inches (width by depth).

b. The designer shall minimize the column size by the use of high-strength steel, etc.

c. Center and outside columns and cantilevered roofs may be considered for locations where they will not obstruct controller view of airport surfaces and traffic patterns.

157. COLUMN RACEWAY. In addition to providing the roof support, the columns may be used for roof drain, sanitary vent, power cable, antenna cables, and grounding systems.

a. Columns used for the roof drains shall be designed such that freezing or rusting from the inside or sweating from the outside will not occur.

b. If a column is used for a sanitary vent, the vent shall not feed into the cable raceway on the cab roof. Care shall be taken to ensure that sanitary exhausts are located away from all fresh air intakes.

c. Minimum inside dimensions shall be 3-1/2 inches by 5 inches (width by depth), to provide space for cabling and piping.

d. Four of the columns shall have 2-inch by 5-inch access slots, provided above the hung cab ceiling to permit wire runs to ceiling lights. One column shall have a 2-inch by 5-inch access slot at the cab desk level, which opens into a 6-inch by 6-inch junction box with removable cover in the wall to permit wire runs from cab ceiling to be wired to cab desk controls.

e. The base of all columns shall extend below the cab floor and be free to accept piping or antenna cable runs to the cab roof, or provisions made to receive the cable runs or piping in the columns in a raised floor section utilizing slots in the columns.

f. The raised floor design shall allow access to the column slots and the floor panels used to access the column slots shall be clearly identified.

158. CAB STAIR. Stairs from the junction level to the cab shall be determined by CHAPTER 5, Section 2, Life Safety requirements.

a. There should be a gate provided at the top of the stairs to prevent personnel accidentally falling into the stairway. The gate shall swing into the cab area and shall be a minimum of 30 inches in height.

b. The stairs and gate shall meet 29 CFR 1960.20 requirements.

159. CAB CONSOLES. The console design shall not obstruct the controller's visibility, while containing all the necessary equipment as shown in Appendix 3 Representative Space Layouts and Console Drawings, Figures 4-7. Consoles should be constructed of plastic laminated plywood or steel frame with plywood faces and should be designed as modules sized to permit removal from the cab. When planning cab console design, ergonomics, standardization, and flexibility shall be major design parameters. A full-scale mockup of the console layout design is recommended before starting construction.

160. FLOOR HATCH AND HOIST. There shall be a remotely controlled, 2,000 lb. capacity, electrical hoist, centered above the tower cab floor hatch. This hoist arrangement shall permit the movement of heavy equipment between the cab and the top elevator floor landing. *If DBRITE equipment will not be installed, the hoist and cab floor hatch are not a requirement.*

a. The minimum dimensions of the hatch shall be 30 inches by 36 inches. The hatch cover should be equipped with hinged swing-out railings, which do not void UL listings, to guard the opening when in use.

b. When the top elevator landing is on the sub-junction level, provide floor/ceiling hatches that are aligned with the cab floor hatch on the junction level.

c. When the fire barrier begins at the cab floor, it shall include a fire rated hatch.

d. The hoist system shall meet all applicable OSHA and ANSI standards.

SECTION 7. SPACE RELATIONSHIPS

161. FLOOR PLANS. Floor plans for the ATCT/TRACON facility shall be developed and should be based on FAA space allocation standards or directives and optimum space relationships for the many specialized functions within the facility. Figure 5-2 through Figure 5-6 contain block diagrams developed for the most common structural components in ATCT and

TRACON facilities. Related spaces are grouped by function and/or physical characteristics and arranged by proximity requirements. Where feasible, conference rooms shall have direct access to administrative space. These block diagrams should serve as the basic requirements for developing concept floor plans. Considerations for developing floor plans for basic structural components are outlined as follows:

a. Tower Shaft. The tower shaft component space centers on the control cab being adequately elevated and correctly oriented on the site. Locate cab stairway on the side furthest away from cab operational areas and arrange the stairwell for minimum impact on the functional cab perimeter. For optimum safety and convenience, cab stairs should transition into tower shaft via a smoke proof enclosure immediately adjacent to the existing stairs, as required by codes. Floor levels below the cab are commonly repetitious.

b. Base Buildings. The ATCT/TRACON and the equipment rooms are the facility focal point. Locate electronic equipment rooms adjacent to the TRACON to minimize cable runs and on an outside wall to permit future expansion of this critical space.

1) The E/G should be housed in a separate building. The E/G building shall be proximate to the base building. The mechanical/electrical room and telco room are functionally and physically similar and should be proximately located but should be physically separated.

2) The mechanical/electrical room may be located in the engine-generator building (see paragraph 128).

3) Electronic equipment rooms and telco rooms are interconnected by cable tray(s). The rooms should be separated and should be proximate. Minimize cable tray penetrations into fire rated walls. The base building cable tray shall interconnect with the ATCT cable trays. Therefore, these equipment rooms should be adjacent to the building link.

4) Since the link is adjacent to the TRACON and ATCT, it best serves as the employee entry. Spaces required to be adjacent to the TRACON are the break room, assistant manager, and lavatories.

5) All ATCT/TRACON spaces, except the tower cab, shall meet FED-STD-795 requirements. The locker room should be adjacent to the break room. The lavatories should be in proximity to the administrative areas. The administrative areas may be divided into two groups – the technical staff and the managerial staff. Managerial staff functions are grouped around the secretarial area and include AT manager, assistant manager, operations officer, facility manager, administrative assistants, secretaries, and receptionists.

6) Receptionists should have visual control over the visitor's entry.

7) Technical staff functions are those that require highly specialized skills for facility operations. Included in the technical areas are support staff, and training and conference rooms.

8) The automation staff should be adjacent to the radar equipment room.

9) Training and conference rooms may be jointly used space. The training and quality

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assurance staff should be co-located with the training areas including the playback and simulator rooms.

10) The simulator room should be adjacent to the radar equipment room.

11) The playback room should be located away from heavy traffic areas. Mechanical equipment room, ATCT/TRACON, communications and radar equipment room, break room, and manager and deputy offices should be on exterior walls.

162.- 165. RESERVED.

SPACE RELATIONSHIPS

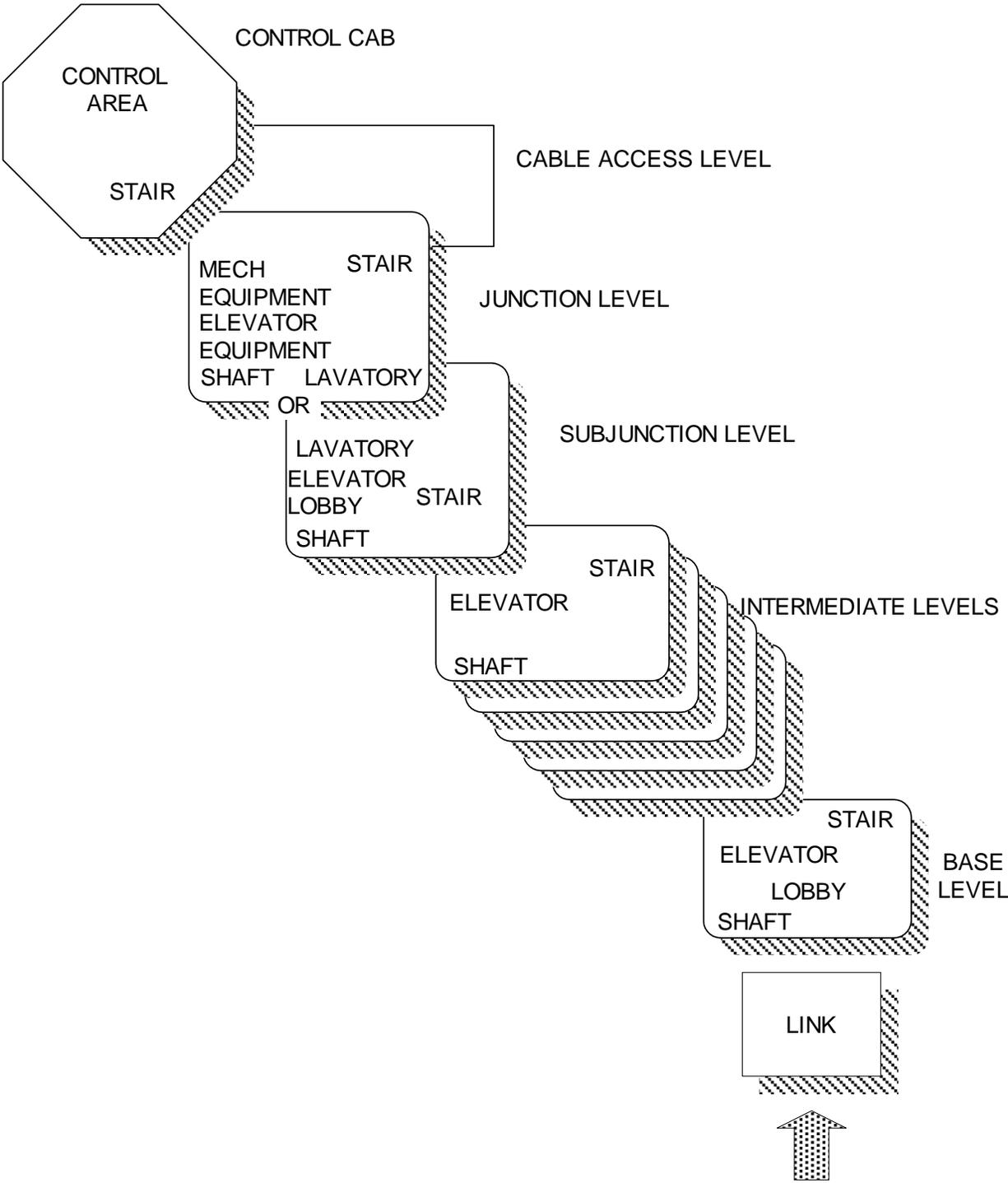


FIGURE 5-2 BLOCK DIAGRAM – NON FUNCTIONAL SHAFT

SPACE RELATIONSHIPS

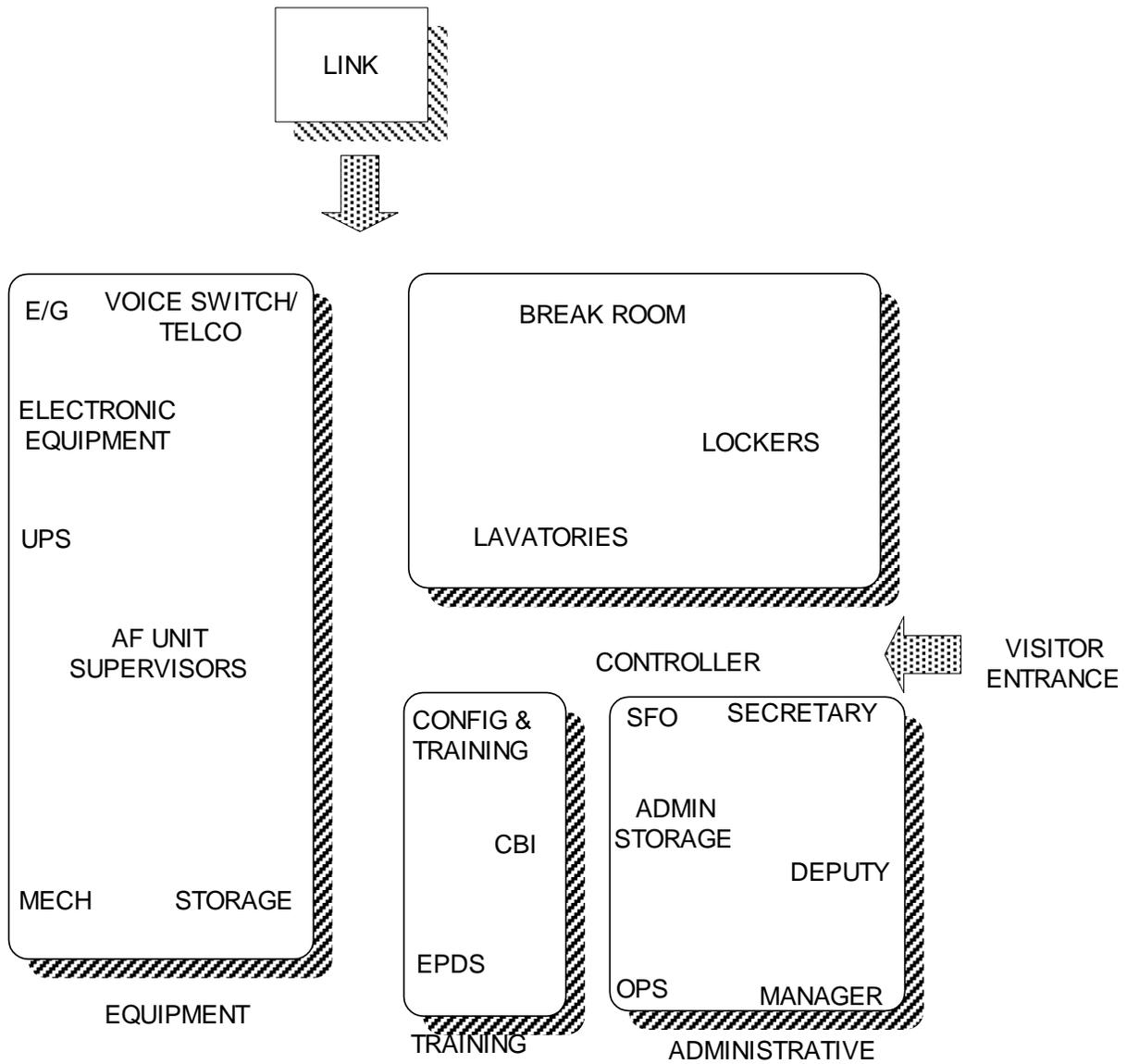


FIGURE 5-3 BLOCK DIAGRAM - ADMINISTRATIVE BASE BUILDING

SPACE RELATIONSHIPS

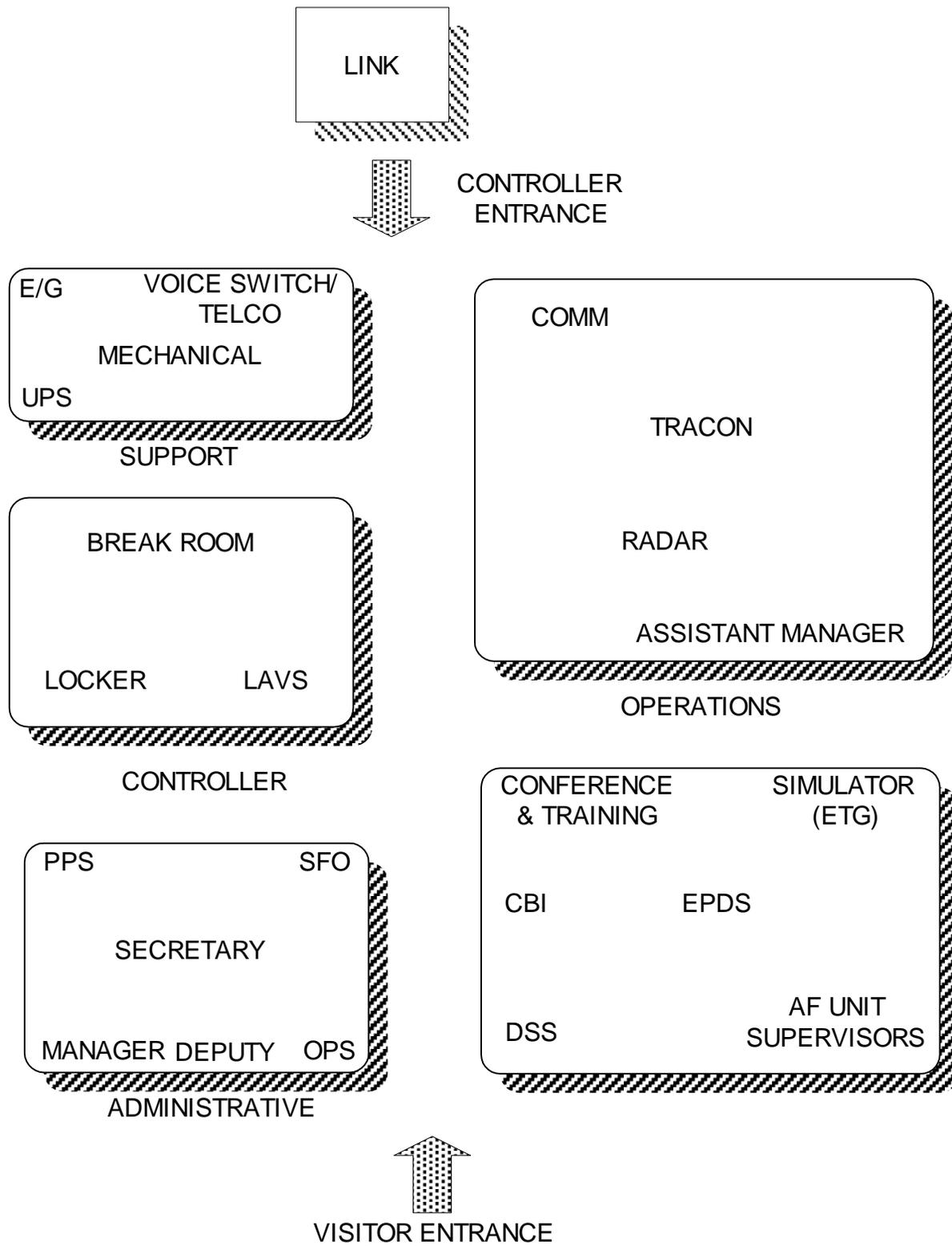


FIGURE 5-4 BLOCK DIAGRAM – ONE STORY TRACON BASE BUILDING

SPACE RELATIONSHIPS

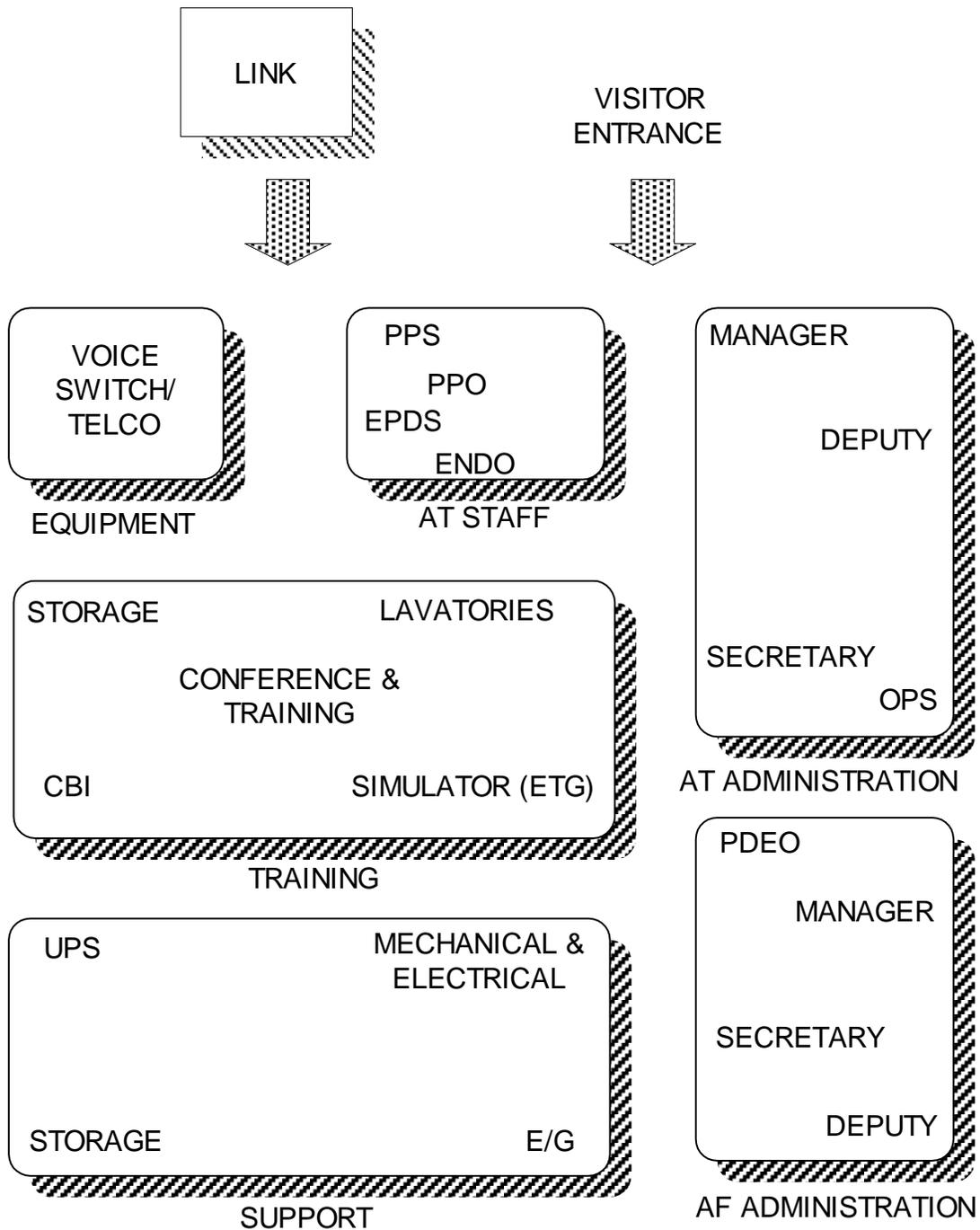


FIGURE 5-5 BLOCK DIAGRAM – TWO STORY TRACON BASE BUILDING (FIRST FLOOR)

SPACE RELATIONSHIPS

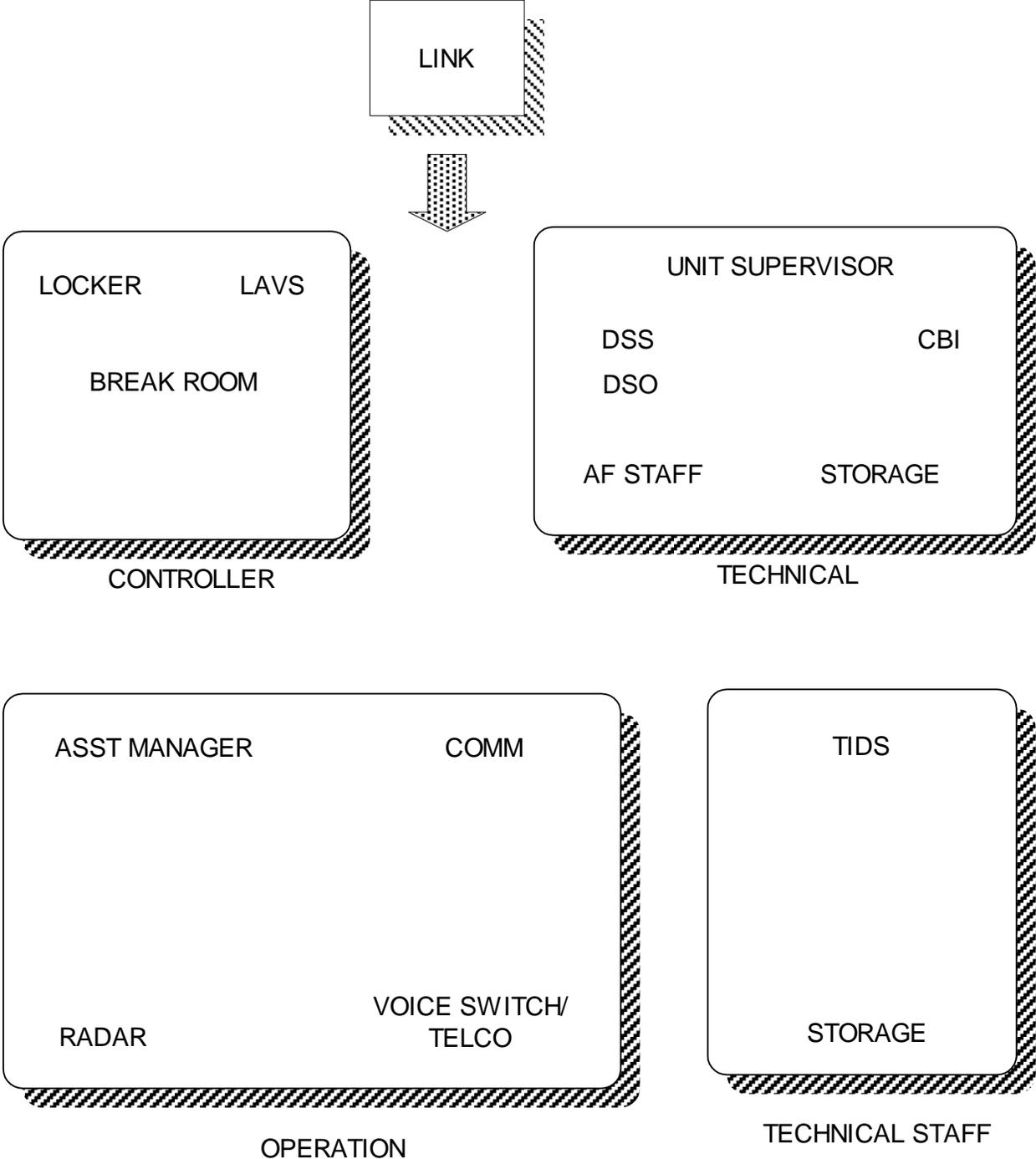


FIGURE 5-6 BLOCK DIAGRAM – TWO STORY TRACON BASE BUILDING (SECOND FLOOR)

CHAPTER 6. STRUCTURAL DESIGN

SECTION 1. INTRODUCTION

165. GENERAL. This chapter contains general guidance including codes, requirements, and loads for the airport traffic control towers and base building structural design. The FAA orders, standards and specifications, and the national codes and publications, identified in this document, shall be the basic references for structural design. Local building codes shall be checked for frost penetration depth, snow loads, wind loads, seismic zones, foundation restrictions, or any other local conditions that may be more restrictive than this order. The structural design shall meet American Concrete Institute - ACI 318, American Institute of Steel Construction - AISC Manual of Steel Construction and American Concrete Institute - ACI 530/ASCE 5/TMS 402, Building Code Requirements for Masonry Structures requirements.

166. BASIC REQUIREMENTS.

a. Structures. It is desirable to provide maximum flexibility for future changes and for adapting building requirements to individual site restrictions. To achieve this flexibility, the cab, shaft, link, and base building should be designed, as much as possible, as independent structures. See paragraph 99.b for construction types relative to combustion characteristics.

b. Coordination.

1) Normal coordination between all the design disciplines is required. However, it is imperative that the structural and architectural designers work closely to assure that the spaces required and the appearance desired is achieved.

2) Floor, roof, and wall penetrations, as well as space requirements for ductwork, piping, cable trays, floor drains, etc., shall be coordinated with the structural elements to avoid incompatible layouts.

c. Future FAA Requirements.

1) Control Cab Base. Consideration should be given to provisions for future cab removal and replacement.

2) Tower Shaft. The tower should be designed and sited to allow a base building installation. The design should also consider optional alternate locations for the base level link.

3) Base Building. Allowance shall be made for orderly future expansion of the base building. Exterior columns and foundations should be designed with consideration for future loads. Exterior walls should be removable without damage to the basic structural frame.

167. RESERVED.

SECTION 2. DESIGN LOADINGS

168. STANDARD LOADINGS.

a. Live Gravity Loads.

1) Cab.

a) Cab Roof.

(1) Local code snow load down, local code wind load uplift, or International Building Code (IBC) wind load uplift, whichever is more stringent.

(2) Antenna dead load, 5 pounds per square foot (psf) minimum. Refer to paragraph 154.l and 169.f for ASDE mounting information detail.

b) Cab Floor - 100 psf. Cab floor must also meet electronic equipment load bearing requirements in FAA-G-2100.

2) Shaft or Base Building.

a) Roof - Local code snow load down, local code wind load uplift, or IBC wind load uplift, whichever is more stringent.

b) TRACON Operations Room - 100 psf.

c) Equipment Rooms (Telco, Communications, Radar, etc.)-150 psf.

d) Mechanical Rooms and Electrical Rooms - 150 psf (or actual planned) (UPS - 250 psf).

e) Storage space, light - 125 psf.

f) Loading Dock - 200 psf.

g) Restrooms - 50 psf.

h) Locker Room - 50 psf.

i) Office Areas - 50 psf.

j) Stairs and Landings - 100 psf.

k) Public Areas (lobbies, corridors) - 100 psf.

b. Dead Loads. Shall be actual weights of materials used, including permanent partitions. Also include permanent equipment weight and forces caused by pre-stressing.

c. Wind Loads. Wind loads shall be determined in accordance with IBC, Structural Engineering Design Provisions or local codes, whichever is more stringent. The wind pressures are then calculated based on the design wind speed and other factors as prescribed by the code.

1) Most FAA standard ATCTs and base buildings can be designed for the static wind pressure per code.

2) All ATCT plans that are intended for use at more than one location shall be designed for a minimum 90 miles per hour wind.

3) Plans intended only for a specific location shall be designed for local wind load requirements.

4) Wind tunnel testing should be considered in new tower designs.

5) All designs shall include the coefficient for "Exposure C" in accordance with IBC. However, the code states "Structures sensitive to dynamic effects, such as buildings with a height-width ratio greater than five, structures sensitive to wind-excited oscillations, such as vortex shedding or icing, and buildings over 400 feet in height, shall be, and any structures may be, designed in accordance with approved national standards." In view of this statement, the following design procedures and guidelines shall be applicable to the design of specified structures:

a) Any structure with a height-width ratio greater than five but less than 6-1/2 shall be designed in accordance with the ASCE-7, Minimum Design Loads for Buildings and Other Structures, using the 50-year recurrent wind speed.

b) A professional structural engineer shall provide calculations for FAA review for the following designs:

(1) Structures mentioned in paragraph 168.c.1) above, which are located in special wind regions or in regions (refer to IBC) having 50-year recurrent wind speed greater than 100 miles per hour.

(2) Any structure having a height-width ratio greater than nine and having a minimum plan dimension less than 34 feet.

(3) Structures located in a hurricane zone region.

(4) All structures shall be designed to have a limiting drift (story lateral deflection/story height) of 0.002 or less due to wind loads.

6) When an Airport Surface Detection Equipment (ASDE) is expected to be installed, all new Intermediate Activity Level and Major Activity Level ATCTs control cabs shall be designed to support a penthouse (ASDE equipment) above the cab roof (ceiling). Coordinate equipment room use to provide adequate ASDE equipment space. Additionally, the penthouse roof shall support the ASDE antenna system. See paragraph 154.1 for additional ASDE requirements.

d. The ASDE system consists of a radar antenna and an 18-foot diameter saucer-shaped plastic cover (rotodome) rotating on a four-legged mounting frame. Intermediate base plates may be required for bolting the mounting frame to the cab structure (see Figure 5-1). Access to the antenna is through the rotodome. The antenna shall be high enough to see over the roof edge at an angle of minus 32.5 degrees with respect to horizontal. For Special Design Loading, see paragraph 169.f Avoid locating large objects in the path of the radar signal as this may have an adverse affect on system performance. Most antennas and air terminals will not impact performance.

e. Airport light beacons shall not be placed on the ATCT roof because the beacon's performance characteristics may inhibit the installation of certain other types of equipment and because of the noise and light reflections it can generate in the cab.

f. Obstruction lights shall be placed as required by FAA orders. Horizontal lifeline/fall protection may be required for outside obstruction light maintenance.

g. Seismic Loads. In accordance with the IBC, dynamic analysis and site response calculations are required at all locations. Except, as a minimum, light fixtures, cable trays, motors, UPS modules, switchgear, and motor control centers shall be mounted in accordance with IBC Seismic Design Category C requirements, using the minimum value for short period and the minimum value for the long period as a minimum. However, for a specific site with higher values than the minimum for the short period and for the long period, the specific values should be used. E/G assemblies, transformers, batteries, and bus ducts shall, as a minimum, be mounted in accordance with IBC Seismic Design Category D requirements.

1) The seismic requirements for ATCT/TRACON facility designs shall be fully supported by calculations signed by a professional engineer. The following publications are applicable to seismic design of mechanical, electrical, and structural systems and the most stringent local or national code shall always be used as guidance:

a) International Building Code. All structures shall be designed to have a limiting drift (story lateral deflection/story height) of 0.002 or less due to wind loads.

b) ASCE 7, Minimum Design Loads for Buildings and other Structures.

c) FAA-STD-032, Design Standards for National Airspace System Physical Facilities.

d) International Plumbing Code (IPC).

e) Sheet Metal and Air Conditioning Contractors National Association (SMACNA), Seismic Restraint Manual, Guidelines for Mechanical Systems.

f) Electronic equipment shall be provided seismic protection in accordance with FAA-G-2100.

169. SPECIAL LOADINGS.

a. Antennas. The structural designer shall provide support for communication, ASDE, microwave antennas, and other special equipment. If there are no other provisions for microwave antennas, standard details shall be shown for mounting a 4-foot diameter antenna on the catwalk railing (using a 4-1/2 inch outside diameter (OD) pipe) including waveguide entrances to the tower shaft which may be cut after tower construction.

b. Cab Glass.

1) Window washing. The structural designer shall investigate whether window washing will be manual or automated and consider these loads in the design of the catwalk and glass support system.

2) Glass maintenance or replacement. The catwalk and roof shall be designed to support glass panels weighing 1,200 pounds minimum each with a minimum 70 SF area; and the hoisting, scaffolding, personnel, and other loads associated with the cab glass replacement. There shall be a capability to change the cab glass panels using a standard design, such as davits to be stored and shipped to the site, to be used in conjunction with post and pad eye buttons installed on the cab roof.

3) Glass Pane Design.

a) Cab glass panes shall be designed for temperature changes and calculated wind pressure considering the height at which they are placed and exposed to the elements.

b) Particular attention should be given to the trapezoidal shape of the panes.

c) See paragraph 151 for window glass design information.

c. Elevators. Design shall be consistent with the load data required for specific elevator type as specified by the architect. Use 100 percent impact for elevator support.

d. Fireproofing. Use actual materials selected dead load.

e. Temperature. Calculations shall be provided for the structural frame, to include temperature change, and temperature loads required for the framing design.

f. ASDE. ASDE includes a radar antenna installed on the control cab roof at certain airports, per paragraph 154.1. The ASDE transmits a signal at a depression angle of negative 32.5 degrees with respect to the horizontal. When ASDE is required, the following are representative of applied loads at the ASDE Base:

1) Dead Load, Rotodome - 5,000 lbs.

2) Lateral Loads.

a) Shear.

- (1) 95 MPH wind - 1,500 lbs.
- (2) 110 MPH wind - 3,000 lbs.
- b) Overturning.
 - (1) 95 MPH wind - 20,000 Ft.-lbs.
 - (2) 110 MPH wind - 38,000 Ft.-lbs.
- c) Seismic - Use IBC Seismic Design Categories.

170. LOADING COMBINATIONS. Calculations shall be provided that prove every building component design has strength adequate to resist the most critical effect resulting from the combination of dead loads, live loads and lateral loads (wind, seismic and earth pressure). Applicable sections in the IBC and ASCE-7 shall dictate the combining methods and their respective load factors.

171. RESERVED.

SECTION 3. MATERIALS

172. STRENGTH OF MATERIALS. The following is a representative structural materials list. Materials for ATCT/TRACON construction are not limited to this list. Minimum acceptable strength of material requirements are:

- a. Structural steel - ASTM A36 - $F_y = 36,000$ pounds per square inch (psi).
- b. Bolts for structural connections - ASTM A325.
- c. Anchor bolts - ASTM A307 or ASTM A36 threaded rods.
- d. Welding electrodes - E70 series, conforming to American Welding Society (AWS) D1.1. "Structural Welding Code Steel."
- e. Concrete.
 - 1) Slabs, walls, footings - $f'_c = 3000$ psi.
 - 2) Precast, prestressed, fill for steel shell piles - $f'_c = 5000$ psi.
 - 3) Cast in place concrete around post-tension anchorage - $f'_c = 5000$ psi.
- f. Reinforcing steel - ASTM A615 - Grade 60 - $F_y = 60,000$ psi.
- g. Welded wire fabric - ASTM A185 using ASTM A82 wire.

- h. Hollow load-bearing masonry units - ASTM C90.

173. RESERVED.

SECTION 4. MATERIAL SELECTION FACTORS

174. GENERAL. The best structural system for a particular application is one that will satisfy the functional and architectural finished structure requirements at minimum cost. Consideration shall be given to future expansion or rearrangement of spaces and costs of maintenance. Generally, the preferred systems utilize material efficiently, provide maximum usable space, minimize special equipment use, and can be constructed by following conventional procedures.

175.-181. RESERVED.

180. ENVIRONMENTAL PROTECTION. Protect structures from moisture penetration and exposure to seawater, corrosive soils, and corrosive atmosphere. Provide water-stops at all construction and expansion joints in concrete walls and slabs below grade where water problems may be anticipated. Use membrane waterproofing for occupied spaces below grade.

183. DURABILITY. Choose materials to assure low maintenance and economic life of the project.

- a. Consider air entrained concrete for structures exposed to freeze/thaw cycle.
- b. Where maintenance is difficult, use corrosion resistant steels or protective coating.
- c. Treat timber for resistance to decay and borer attack.

184. RESERVED.

185. TROPICAL ENVIRONMENTS. Steel structures should not be considered for facilities in coastal regions and the tropical environment of Puerto Rico and the U.S. Virgin Islands. The high temperature, humidity, and salt content of breezes in the coastal areas combine to cause rapid steel structure deterioration. Steel maintenance in tropical regions is labor intensive, expensive, and an endless effort. Materials suited for the tropics include cast-in-place and pre-cast reinforced concrete and concrete blocks.

186.- 187. RESERVED.

SECTION 5. SHAFT AND BASE BUILDING FRAMING SYSTEMS

188. STEEL. Generally, rigid frames are easier to maintain than braced (with steel) frames, because fewer surfaces are subject to corrosive effects. However, rigid frames have a higher unit

material and connection cost. Horizontal deflections will generally be smaller for a braced frame than for rigid frames. Diagonal wall bracing may be undesirable when considering architectural or functional requirements. Braced frames generally can be erected faster than rigid frames, in particular, welded rigid frames. Braced frames are usually the preferred steel construction types if they can be coordinated with the architectural requirements. Exposed structural steel shall meet fireproofing requirements.

189. CONCRETE.

a. Pre-cast concrete is only acceptable in lower seismic zones, NEHRP Zone 1 – 4, and shall not be used in Zone 7. Where large numbers of units of similar size and shape are required, pre-casting is preferred. Use of pre-cast units also reduces the amount of shoring required and reduces delays due to the weather. Pre-casting allows better finishing and curing than cast-in-place construction. It has more uniformity, more dimensional accuracy, and uses higher strength concrete. All concrete construction shall have crack dispersion control joints.

b. Pre-stressing is generally used to control deflection of unusually long spans, to minimize depth, to aid in developing continuity, or to join pre-cast elements. Pre-stressing requires higher strength concrete, steel tendons, and skilled labor. Pre-stressing is particularly useful for tower shaft construction to resist tensile stresses on the structure due to overturning moments. Post tensioning shall not be used due to possible bomb blast stresses. Refer to Order 1600.69, Appendix 19.

c. Pre-stressed construction members should be designed on an individual case basis to accommodate hangers and penetrations to aid in adding accessories for future expansion.

190. RESERVED.

SECTION 6. CONTROL CAB FRAMING SYSTEM

191. GENERAL. Roof and frame construction is generally limited to steel construction since columns shall be as small as practical to allow maximum visibility. Since cross bracing would also interfere with visibility, cabs depend on frame action to resist lateral load. However, knee braces may be installed above the ceiling to control deflection.

192. SPECIAL CONSIDERATIONS. Refer to CHAPTER 5 ARCHITECTURAL DESIGN, paragraphs 156 and 157, for special considerations concerning column and raceway design.

193. RESERVED.

SECTION 7. FLOOR AND ROOF FRAMING SYSTEMS

194. STEEL.

a. Open-web steel joists are adaptable to a wide range of spans, from eight feet to over 100 feet. Floor joist spacing is generally two feet and the roof may be as much as seven or eight feet. Joist construction features rapid erection, open webs for piping, ductwork, or conduit runs, and adaptability to irregular column spacing. Calculations for wind uplift on the roof shall be prepared. Calculations for floor framing for relatively large open areas shall also be prepared to ensure that the framing design minimizes the potential annoying vibrations.

b. Steel beam and girder systems are usually most economical in the 20 to 30-foot span range. Beams may be spaced to suit slab or deck limitations. Concentrated loads and heavy live loads are more easily accommodated than with steel bar joists. Stair and elevator openings, etc., are easily framed. The system is more readily adaptable to future framing changes. Beams and girders are generally more economically fireproofed using sprayed-on or cementitious materials.

c. Roof decks for steel framing systems are commonly 1-1/2-inch deep steel roof decks. The deck is welded to the steel framework and may be designed as a lateral diaphragm to distribute horizontal loads to vertical resisting elements. The roof system shall be checked for sufficient pitch or adequate stiffness to prevent ponding. Lightweight insulating concrete may be used to provide roof insulation, to develop drainage control slopes, and to provide added dead load to resist wind uplift. Consider roof deck construction with maximum practical pitches. The minimum pitch should not be less than 1/4-inch per foot.

d. Floor slabs for steel systems may be one of the following preferred options.

1) Conventionally formed slabs that may be designed as one-way or two-way slabs depending on the beam spacing.

2) Steel deck centering used as a permanent form, but it is generally limited to fairly short spans.

3) Composite steel deck is generally the most efficient floor slab. The deck acts as form, as positive reinforcement, and in some cases, can achieve a two-hour fire rating with no additional treatment.

195. CONCRETE. There are numerous concrete slab systems that could be considered in tower construction. A few of these would be concrete beams and girders with one-way and two-way slabs, flat slab, flat plate, concrete joists, and waffle slabs.

a. While these systems offer certain advantages, such as built-in fire resistance and possible lower story heights for flat plate design, there are several factors limiting their use in tower construction. Concrete systems are most economical when there are many form system re-uses. This implies large areas with regular column spacing and few openings that have to be specially formed. Generally, the base building interior columns need to be irregularly spaced to fit the interior wall layout.

b. The housed activities space requirements vary and the room layout does not lend itself to repetition. The shaft floors, on the other hand, are repetitious; however, they have numerous openings for utility chases, stairways, elevators, etc., that restrict the efficiency of a concrete system. As a result, the concrete slab systems may have limited suitability to tower construction.

196. RESERVED.

SECTION 8. WALLS AND PARTITIONS

197. GENERAL. The architect selects wall and partition materials. Whether materials are concrete, concrete masonry units, metal panel, masonry, or a metal stud, they should be designed in accordance with national codes and publications listed in Appendix 1.

198. EXTERIOR WALLS. The exterior walls are designed for the respective wind loads, bearing loads, seismic, or other loads that they shall support.

199. INTERIOR WALLS. The interior walls design loading is their actual load but not less than 5 pounds psf perpendicular to the walls. The loaded wall deflection shall not exceed 1/240 of the span for walls with brittle finishes and 1/120 of the span for walls with flexible finishes.

200. WALLS BELOW GRADE. Basement and retaining walls will generally be concrete construction. They shall be designed to resist the material retained lateral pressure, including surcharge and hydrostatic head, but not less than the force exerted by an equivalent 30 pounds per cubic foot fluid weight. Walls below grade shall have no water leakage due to critical equipment below grade.

201. RESERVED.

SECTION 9. CONSTRUCTION AT OR BELOW GRADE

202. SLAB-ON-GRADE. When walls and columns are founded on separate spread footings, the concrete floor slab shall be designed as a separate "floating" slab. Concrete shall have a minimum five inches thickness for foot and light pneumatic wheeled traffic and be reinforced with at least 6 x 6 - W1.4 x W1.4 welded wire fabric, located two inches from the top surface.

Slabs shall be placed over a vapor barrier on a minimum six inches compacted stabilized aggregate base. Thicken slabs under concrete block walls.

a. Isolation joints shall be used at all columns, wall footings, machine foundations, or other restraint points. The joints permit horizontal slab movement caused by drying shrinkage and they allow vertical movement that invariably occurs because of the differences in unit soil pressures under floors, walls, columns, and machinery footings. Isolation joints extend the full slab depth and may be formed with a pre-molded joint filler or two 30-pound roofing felt layers.

b. Control joints shall also be used to control random cracking. Construction joints shall be located and sawed to act as control joints. The maximum spacing between control joints and between construction joints shall be in accordance with American Concrete Institute (ACI) standards. Preferably, slab panels should be placed in a lane pattern with a minimum three-day delay between adjacent placements. Joints shall be sealed with a two-component polysulfide base sealant to prevent infiltration of foreign material into the joint.

203. FOUNDATIONS AND WALLS. Reinforced concrete foundations shall be provided for perimeter walls and grade beams. All basement walls shall be reinforced concrete, waterproofed, waterstopped, and provided with foundation drains. Where a storm sewer drainage system is available, connect foundation drains to the storm sewer drainage system.

204.- 206. RESERVED.

SECTION 10. FOUNDATION REQUIREMENTS

207. SUBSURFACE INVESTIGATION. Foundation design shall be based on recommendations and information contained in a soils report.

a. The designer will provide the soil consultant with appropriate information, such as building locations, description of structural system, wall construction, column loads and spacing, etc., for the consultant to conduct a subsurface investigation.

b. The soil report should include a site description, a field investigation summary, laboratory tests and borings, groundwater conditions, and a subsurface condition description including seismic geological conditions.

1) The report should also make specific recommendations on the foundations types; allowable soil bearing pressures; anticipated total and differential settlements; types of piles, capacity, length; special problems, such as de-watering or existing structures protection; lateral soil pressure for basement or retaining wall design; soil corrosion potential and required protection for steel pilings; and any other information that should be considered in the design of construction of the foundations.

2) The report should also specifically state potential soil liquefaction, fracture, rupture, location, and distance to nearest fault or other seismic geological information.

c. Costs should be included to mitigate discovered seismic geological concerns. Sites prone to rupture or liquefaction should be used only as a last resort.

d. The Earth Electrode System (EES) establishes the electrical connection between the facility and the body of the earth. This connection is necessary for lightning protection, power fault protection, and the minimization of noise between interconnected facilities. The subsurface investigation and site survey shall determine the soil resistivity, geological features, and review local climatic conditions, which are: incidence of lightning, frost-line depth, moisture content, and annual rainfall.

208.- 209. RESERVED.

SECTION 11. SUPPLEMENTAL CONSIDERATIONS

210. CONSTRUCTION. Certain construction details may cause problems in tower facilities; some of them are listed here for the designer's consideration:

a. Exposed steel columns of tower shaft may be subjected to varying expansion because of the sun. The physical results of this differential expansion shall be considered.

b. Condensation, rust, and staining may result when steel columns are erected with a flange exposed outside, insulation, in the web and the other flange exposed inside.

c. Hollow tubular columns in tower shafts may compound acoustical problems.

d. Headroom clearance above tower stairs is critical.

e. Construction should assure adequate height and space is provided for the cable access level.

211. STRUCTURAL DESIGN CALCULATIONS. Structural design calculations are required to be submitted and will be retained by the FAA.

a. All design notes shall be indexed and arranged in an orderly manner, with appropriate sketches, so that any element may be easily identified. Complete structural calculations are required covering all parts of the structures and all related items such as baseplates, anchor bolts, manholes, stairways, platforms, equipment supports, underground tank foundations, etc. All design loads shall be identified, and design methods and assumptions shall be indicated.

b. When computer printouts form a portion of the design notes, the designer shall include all input diagrams and information needed to relate the printout to the design elements.

c. The computer programs utilized shall be identified and a brief description of each shall be included.

- d. All structural engineers' calculations shall be submitted to the FAA for acceptance.

212. STRUCTURAL DRAWINGS. In addition to other details and calculations, the first sheet of structural drawing shall contain a list of the design loads and of the strengths of materials used, including foundation capacity.

213. PROFESSIONAL REGISTRATION. All original tracings of construction drawings and the first page of all specifications, reports, and calculations shall be signed and sealed by a registered/licensed professional engineer or architect. An ATCT project that is in an IBC seismic Category C or higher shall be sealed and signed by a professional engineer from that state.

CHAPTER 7. MECHANICAL DESIGN

SECTION 1. INTRODUCTION

214. GENERAL. This chapter contains the basic design data, criteria, and guidelines necessary to develop a heating, ventilation, and air conditioning system for ATCT/TRACON facilities. Variations have been specified and limitations imposed in this chapter in order to assure the compatibility of mechanical systems with other design requirements in this handbook. The HVAC system and components shall maintain the ATCT and TRACON critical space environment within the occupying system reliability requirements.

215. REFERENCES. As previously mentioned in this order, a list of references is included in Appendix 1. It is important for the designer to obtain the references applicable to the mechanical design effort because specific chapters within those documents are referenced as minimum design criteria in this chapter. *Also refer to the "Terminal Facilities Business Service Mechanical Design Standard/Requirements" document developed by ATB-320 that complements 6480.7D.*

SECTION 2. PRELIMINARY DESIGN CRITERIA

216. EXISTING HVAC SOURCES USE. Preliminary consideration shall take into account the location of the ATCT/TRACON facility as it relates to the overall airport complex.

a. In some locations, a central heating and cooling source may be available that is capable of handling the ATCT/TRACON facility requirements.

b. The existing HVAC system identification shall consider whether the system is sized to meet the present HVAC load, whether it is operating as designed, if the system is reliable and available, alternative back-up heating and cooling sources are provided, or whether it can be modified to provide a more efficient operation. These questions shall be answered in the architect/engineering (A&E) firm's site report.

c. In the event that existing HVAC equipment and energy sources are available (packaged or central), a cost analysis should be performed to determine the feasibility for revising or modifying it.

d. Factors to be considered include energy source, redundancy, chlorofluorocarbons (CFC) replacement, energy conservation, long-term availability, cost projection, present operations, and serviceability.

217. EXTERIOR DESIGN TEMPERATURES. Heating and cooling load calculations shall be made using the following exterior design temperature criteria.

a. For specific ATCT/TRACON facilities with known locations, the designer shall use the criteria set forth in the ASHRAE Handbook, Fundamentals, Table 1A Heating and Wind Design Conditions and Table 1B Cooling and Dehumidification Design Conditions. When the ASHRAE handbook is used, the designer shall use the 99 percent design dry bulb column for winter and the one percent columns for summer.

b. Design elements most affected by exterior design temperature are the tower cab HVAC capacity, base building HVAC capacity, total CFM, and E/G Room exhaust.

TABLE 7-1 EXTERIOR DESIGN TEMPERATURE ZONES (DELETED)

218. INTERIOR DESIGN TEMPERATURES. The mechanical systems design serving an ATCT/TRACON facility shall be based on maintaining the following temperature and humidity requirements:

a. Office spaces and break rooms, storage rooms, rest rooms, kitchens, hallways, administrative rooms, and other personnel areas of electronic rooms:

- 1) Winter - 75 ± 3 degrees F, dry bulb.
- 2) Summer - 75 ± 3 degrees F, dry bulb.
- 3) Humidity requirements – 30 to 70% R.H.

b. Mechanical Equipment Rooms..

- 1) Normal Operation - 55 degrees to 85 degrees F.
- 2) Relative Humidity - 0 percent to 95 percent.

c. Critical Spaces (see paragraph 223 for areas considered critical spaces).

- 1) 73° F stable $\pm 2^\circ$ F for periods of 6 hours minimum.
- 2) 35 to 60% R.H. stable $\pm 5\%$ for periods of 6 hours minimum.

219. DESIGN ANALYSIS. HVAC system peak load calculations shall be performed. Computer analysis should be used to aid the designer in calculating energy loads (see paragraph 224), energy consumption, highlighting energy losses, selecting the best HVAC equipment, sizing equipment capacity for economy, and testing effectiveness of differing building characteristics.

220.- 221. RESERVED.

SECTION 3. FUNCTIONAL REQUIREMENTS

222. GENERAL. The primary HVAC system design objective is to provide environmental control for electronic equipment and personnel. In electronic equipment areas, provisions for temperature and humidity control within the room and under the raised floor shall be installed. Special attention shall be given to factors involving installation, maintenance, operation, and reliability with consideration given to diversity and economics. ATCT HVAC system design simplicity for all ATCT facilities shall be a design goal. It is recommended that variable air volume (VAV), constant air volume, multi-zone, direct expansion package, or split systems be analyzed in accordance with paragraph 219. HVAC equipment should be limited to serving one or two floors.

223. CRITICAL SPACES. Certain spaces in any ATCT/TRACON facility are considered critical and shall have the capability to maintain certain temperature/humidity design conditions (see paragraph 218.c). Normally critical spaces are the control cab, communications equipment room, telco room, TRACON operation room, and the radar and ARTS equipment rooms. All cooling systems (central air handling units, DX package units, DX split systems, etc.) serving these spaces shall be connected to the essential power system, if existing, and shall have 100 per cent redundancy and preclude any single-point failure. Electronic equipment rooms with raised floor shall be cooled by multiple floor mounted computer room units. Rooms without raised floor shall be served by overhead distribution from adjacent air handling units. Air conditioning equipment serving critical spaces shall be provided with low ambient control to allow for cooling in the winter season.

224. LOADS. Total heating and cooling loads shall be based on the design analysis as described in paragraph 219. Special electrical loads associated with the technical equipment in critical spaces shall be obtained from the latest information available, supplied by the electrical load study (refer to paragraph 286.a). The designer shall consider future expansion when sizing heating and cooling HVAC capacity.

225. RELIABILITY. The HVAC system design shall allow the critical spaces to function under routine and emergency conditions.

a. The HVAC system shall have a changeover capability for cases of prime equipment failure so that critical spaces will be provided with conditioned air until the primary equipment is repaired.

b. The changeover control to back-up equipment shall be automatically accomplished.

c. Reset to primary equipment should be by manual controls.

d. See commentary for additional information and reliability data for HVAC equipment.

226.- 229. RESERVED.

SECTION 4. SPACE REQUIREMENTS

230. GENERAL. Each ATCT/TRACON facility space or room has a unique function and thus, specific HVAC requirements as defined in paragraph 218. Since all ATCT/TRACON spaces and the various equipment are not found in all facilities, the designer shall, in coordination with the designated approval authority, determine the spaces and equipment necessary for proper ATCT/TRACON configuration. Space and equipment usage requirements shall be supported by appropriate FAA specifications/standards/orders.

231. BASIC REQUIREMENTS. Energy costs need to be considered in the design of the HVAC system. Reheat use shall be minimized in non-VAV applications. All critical spaces defined in paragraph 223 have specialized, redundant HVAC requirements. To eliminate problems associated with noise, vibration, and access, locating HVAC and related equipment above the ceilings in occupied critical areas should be avoided.

a. **Roof Equipment.** To the maximum extent practical, avoid locating equipment on the roof of any facility. If equipment must be located on the roof, it shall be provided with the proper stand-off distances from building edges in accordance with OSHA 29 CFR 1910 requirements. Items such as air supply and return should be designed accordingly.

b. **Separate Structures.** When the tower and TRACON building are separate structures, the cab and base building shall have independent HVAC systems. The following paragraphs provide the designer with the HVAC requirements for all spaces within an ATCT/TRACON facility.

c. **Control Cab.** The control cab is a poorly insulated glass box subject to the maximum effects of changes in atmospheric conditions. Solar gain, greenhouse effect, humidity, conductive heat loss, and convection are forces that influence the design of a specialized cab HVAC system.

1) Proper air distribution shall be controlled to maximize the comfort in the control cab. When necessary, ceiling fans should be considered to improve air distribution throughout the facility.

2) Supply air should be equally distributed around the perimeter of the cab and operated continuously at constant volume.

3) Air distribution should be along the perimeter to prevent glass fogging.

4) Return air should be from registers located near the floor or down the stairway and designed to minimize noise transmission from the air handlers.

5) The HVAC system and air handlers are usually located in the junction level, just below the cab, to minimize system losses. Equipment mounted on the cab roof is generally too noisy for the cab environment and is too difficult to maintain.

6) Design the cab HVAC system as multiple units in parallel to provide 100 percent redundancy.

7) Cab insulation should be chosen carefully and provided for all cold metal surfaces to eliminate condensation problems.

8) The cab HVAC system shall serve only the cab space and the heating and cooling coils should have variable output stages.

9) The HVAC system shall be connected to the essential power distribution system. Failure of one unit shall allow for continuing operation of the second unit.

10) Cabs should be equipped with more than one temperature sensor to allow averaging temperatures throughout the cab.

11) Interlock air handlers with local duct smoke detectors and extinguishing systems and the roof top emergency vent fan.

12) Cabs with raised floors require under floor humidification (see paragraph 218.c).

13) The cab HVAC system may be equipped with an economizer cycle in accordance with paragraph 242.o.

d. Junction Room and Subjunction Rooms. Mechanical and electrical equipment rooms require heating and ventilation. The design engineer, based on site-specific conditions, will decide the most economical solution.

1) Cab stairwells and elevator lobbies should be heated and cooled with minimum ventilation. Stair vestibules have special ventilation requirements per CHAPTER 5, paragraph 98. Electronic equipment rooms generally have constant loads; therefore, they can be cooled with multiple small air handlers mounted on the raised floor or with overhead distribution for equipment rooms without a raised floor system.

2) Systems serving communication, microwave, or other specialized equipment spaces should be on essential power and be separate from the control cab system.

e. Tower Base Level and Link. These spaces are usually cooled and heated from systems located in an adjacent base building. The air supply distributed into the tower lobby will be ex-filtrated into the various tower utility and stair shafts.

f. TRACON Operations Room. Raised floor grilles shall be sized and located to provide proper air distribution. Where raised floors are not utilized or where two separate equipment and people conditioning systems are used, dampers in overhead system shall control proper air distribution. Either system designed for use in the TRACON shall provide a comfortable working environment.

1) Economizer cycles for the HVAC system shall not be utilized, avoiding exposure of critical electronic equipment to wide fluctuations in humidity.

2) Under-floor pressure and air volumetric delivery, in cubic feet per minute (cfm), should initially be balanced for the design load. The system should be re-balanced to take

advantage of additional design capacity, when future equipment is added.

3) Outside air should be carbon filtered at the make-up air intakes for the TRACON operations room.

4) TRACON Operations rooms equipped with either ARTS II or ARTS IIIA consoles should have an allowance for 850 Btu/hr radiated heat per display (including future displays).

5) Design should consider potential STARS console use as that technical data and specifications become available.

g. Radar, Communication, and Telco Rooms. These spaces house solid state electronic equipment and require complete heating and air conditioning.

1) Cooling and humidity control is required for reliable equipment operation and cooling loads are generally constant, 24 hours per day, except for additions or equipment modifications.

2) Humidification is required to prevent electrostatic charges from derogating equipment performance. Multiple small floor mounted air handler units designed for computer room environment should supply each equipment room raised floor. Two air handling units shall house humidifiers, and for redundancy, each shall be sized for the maximum load.

3) Ventilation requirements are based on occupancy, and the designer shall collect information about room personnel occupancy.

4) Specialized computer room HVAC systems with air distribution through the raised access floor shall be installed, and high efficiency air filtration shall be integrated into the systems to minimize dust and contaminants.

h. Administrative Spaces. These spaces require normal office environment cooling, humidification, and heating systems. Heating and cooling loads are variable. Administrative spaces are not normally occupied more than eight hours a day and should be zoned by occupancy hours and similarities in comfort control requirements. Use night setback thermostats in areas occupied for eight hours per day. HVAC systems with VAV are preferred and zones should be determined by building size and layout.

i. Break Room. Provide HVAC capacity for 24-hour per day operation to handle the heat generated by existing and planned vending machine, cooking equipment, and refrigeration compressor associated with under-the-counter refrigerators and drinking water remote chillers when provided. The kitchen area shall have its own exhaust fan activated by a switch located close to the cook-top or microwave oven. TRACONs and ATCT base buildings without a TRACON have similar break rooms.

j. Toilet, Shower, and Locker Rooms.

1) Provide tempered conditioned supply air ducted directly to toilet room ceilings in the amounts only as required to compensate for heating or cooling thermal envelope loads; the remaining air required for the exhaust volume shall be provided via the return air component

discussed above.

2) Makeup air for toilets should generally be introduced via return air ceiling plenum grilles or registers (in base buildings) or via acoustical transfer ducts (returns) from adjoining circulation corridors. Louvered door makeup air shall not be used if toilet room entrance walls are fire-rated; nor should door louvers or undercuts be considered if requirements exceed 100 cfm.

3) In base buildings the exhaust fans serving toilets (and adjoining janitor closets) shall be interlocked with the building HVAC fan(s).

4) In non-functional shaft towers, supply toilets completely with conditioned air (via the cab system) and exhaust via a fan switched with the toilet room lighting.

5) In low activity buildings without central HVAC systems, equip toilet rooms with an exhaust vent fan operated with the room lighting switch.

k. E/G Room. For summer conditions, provide an exhaust fan that is mounted to the side or on the building roof and is weatherproof for space ventilation, activated by a thermostat with set point at 80 degrees F (adjustable). If normal climate outdoor ambient preclude maintaining E/G space at 80 degrees F by merely introducing outdoor air, then provisions should be considered to maintain room temperatures between 80 and 95 degrees F. The need for this space may be eliminated when a packaged E/G system is to be used (see paragraph 128).

1) Design shall preclude drawing outside air that could be contaminated by the battery room exhaust.

2) An additional, high volume fan is required for simultaneous operation with and by (via the essential power buss) the engine-generator set. This fan shall be sized to draw air through the E/G space at a rate sufficient to provide the necessary heat removal for an E/G with a remote radiator.

3) Alternatively, a two-speed, thermostatically activated fan with activation setpoints at 85 and 90 degrees F, sized as noted above, which is interlocked, high speed, to operate with E/G operation may also be considered.

4) Air intake for both normal ventilation and high-volume exhaust fans should be via a low efficiency filtered, storm-proof outdoor air louvers, or intake hoods, with multi-blade (sectioned) low-leakage, motorized control dampers (insulated airfoil dampers or similar type preferred for all heating climate zone I through III inclusive). Dampers on fan intake throats should be of similar type, motorized, and interlocked with either fan operation or barometric backdraft.

5) For installation in colder northern regions, consider a low ambient thermostatic damper control to interlock intake damper blade sections for the high volume exhaust fan to preclude full damper area from opening on E/G start-up when outdoor ambient is below freezing. Other design options can be considered.

6) For E/G sets equipped with bed-rail mounted integral radiators, the high volume exhaust fan is not typically required as air is drawn over engine and discharged to atmosphere via the integral radiator fan (verify requirements individually for such installations). Provide E/G space with a thermostatically-activated unit heater to maintain this space at no less than 50 degrees F.

l. Mechanical/Electrical Rooms. These rooms require ventilation in summer and minimum heating in winter to maintain the required equipment room temperature of 55 to 85 degrees F. Provide a unit heater activated by an adjustable thermostat set at 55 degrees F. Ventilation is usually via an exhaust fan and louver with a barometric damper. Vent combustion air supply provisions should be made when boilers are located in the room.

m. Utility and Elevator Shafts. These spaces usually require natural ventilation only. Provide storm-proof louvers to the outside at the top portion of each shaft. Air intake at lower levels may be via passage door, space under doors, or louvers at the base level. Heat utility chase spaces containing water pipes and drain lines to maintain a minimum 55 degrees F temperature.

n. Stair Shaft. Space conditioning for tower stair shafts is generally not required, except they shall be controlled to paragraph 218 mechanical room standards. Provide for heating stair sections above the top elevator landing that leads to the cab. See CHAPTER 5, paragraph 98 for additional smoke proof enclosure requirements.

o. Storage Rooms. These spaces require the same design criteria for HVAC as for administrative spaces (refer to paragraph 218). This will allow for possible future conversion into office space.

p. UPS Equipment Room. This room shall be served with two completely redundant (essential power feed) cooling-only, constant volume air conditioning systems. Air supplied to this space shall be 100 percent filtered. Commonality of system ductwork, air-intake louvers, and plenums is acceptable.

1) The essential power system shall be part of the essential system serving other critical HVAC base building areas.

2) Rooftop air-cooled direct refrigerant expansion condensing units are permitted when chilled water is not available as a primary cooling source or when the rooftop unit serves as the redundant back-up cooling system. Provide for automatic switchover in the event of failure of the primary unit. Verify UPS heat rejection for each site for the specific equipment to be provided.

3) Room design temperatures shall be in accordance with the mechanical equipment room standards (see paragraph 218), year-round, stabilized at a particular value once initially established and not varied over seasonal periods.

4) Air distribution shall be via an overhead or low sidewall supply directed toward the UPS gear base (integral) ventilation intakes. The UPS gear cooling load is continuous 24-hours per day, year-round and is approximately constant regardless of associated air traffic activity/TRACON equipment load imposed on the gear.

5) With the UPS gear, consider the option of incorporating an airside or hydronic run-around-loop heat recovery system or air-to-air heat exchanger for preheating winter ventilation air for other base building HVAC fan systems. Outside air economizers shall not be used due to dust/humidity exposure.

SECTION 5. SPECIAL REQUIREMENTS

232. GENERAL. The selection of the HVAC system and the associated equipment shall be accomplished so that standard manufactured and certified products with a background of reliable, energy efficient performance is assured. The American Refrigeration Institute (ARI) shall rate all HVAC equipment. In addition, the designer shall avoid complicated and overlapping designs and layouts in meeting HVAC requirements in all ATCT/TRACON facilities. The HVAC system shall also meet all applicable ASHRAE standards to include, but not be limited to, ASHRAE 62, ASHRAE 55, and ASHRAE 90.1. Refrigerant systems shall comply with the Order 1050.18, Chlorofluorocarbons and Halon Use at FAA Facilities. Refrigerant monitoring shall be provided in accordance with ASHRAE 15, Mechanical Refrigeration Safety Code.

233. AIR DISTRIBUTION.

a. The air distribution system should follow the configurations and patterns that are standard to the industry (SMACNA standards). Use low and medium pressure ductwork systems where possible. Avoid duct sections with inherently high airflow resistance. Minimize sharp turns and branching patterns that create airflow turbulence. Ductwork should be thermal/noise insulated and should be obstruction free from auxiliary hardware. Design ductwork to use minimum fan horsepower. Consider duct lining material and exterior insulation, required reducing possible moisture build-up, and molding growth.

b. HVAC system noise control is required for ATCT/TRACON facilities. Design the Cab and TRACON operations room HVAC systems for airflow noise levels limited to 35 NC. The design for the HVAC systems serving the electronic equipment area, offices, conference rooms, and training rooms shall limit the airflow noise level to 45 NC. Use sound traps where return air passes through sound treated walls. To minimize HVAC noise, mount equipment on vibration isolators. Rooftop equipment may require installation of noise traps on the supply and/or return air duct openings depending on the unit configuration, fan location, and working characteristics. All rooftop mounted air-handling systems and packaged air conditioning systems shall be mounted on a minimum base of 6-inch lightweight fill concrete or equivalent for noise attenuation.

c. Ceiling fans should be considered for installation in tower control cabs and administrative spaces for circulation of conditioned air and ventilation.

d. All air ducting should be designed to eliminate noise.

234. AIR FILTRATION. The inclusion of highly sensitive electronic equipment in ATCT/TRACON facilities requires the use of high quality air filtration systems.

- a. High-efficiency type filters shall be installed in equipment serving critical areas. In addition, minimum 2-inch-thick throwaway 30 percent pre-filters shall be used in all units.
- b. Filters shall provide fuel odor protection. If severe problems are anticipated due to site location, charcoal filters, or HEPA may be used for the outside air intakes serving critical equipment rooms. Size, maintenance, and cost of these filters make them impractical for general use.
- c. High-efficiency filters shall be rated at 95 percent, minimum, efficiency by ASHRAE Standard 52.1, Dust Spot Procedures for Testing Air-Cleaning Devices.
- d. Electrostatic air filters should be considered in critical spaces in locations with high ambient dust levels such as airports in desert areas. During design, care should be taken such that these filters shall not produce electronic feedback or allow harmonics back into the system.
- e. Additional air quality guidance is contained in ACGIH, EPA, NIOSH, and ASHRAE including ASHRAE 62 guidelines and recommendations.

235. VENTILATION. For energy conservation, outside air ventilation in conditioned spaces shall be provided in accordance with ASHRAE Standard 90A; and for acceptable indoor air quality use ASHRAE Standard 62. Base ventilation rates on required CFM per person. ASHRAE Ventilation Rate Procedure and Indoor Air Quality Procedure may be used as alternate procedures. Generally, buildings with conditioned space over 3,000 square shall be designed utilizing a centralized HVAC system, providing continuous air movement. For buildings with less than 3,000 SF, room mounted units shall be considered. Outside air intakes shall be located away from exhaust fans, stacks, toilet, food preparation hood vents, combustion exhaust, aircraft fueling operations, trash dumpsters, or any sources that might contaminate intake air. Design may consider air-to-air heat exchangers for energy conservation.

236. HUMIDITY CONTROL.

- a. Humidification. All electronic equipment requires controlled and stable humidity (refer to paragraph 218). The designer shall provide humidification as required for electronic equipment spaces only where load calculations indicate humidity control is warranted. Special care should be taken by the design engineer to specify humidifiers based on site water quality, energy efficiency, installation costs, and operating/maintenance costs. Care should be taken in specifying reliable humidistats and their location. Economizers, even with enthalpy controls, are not to be used for HVAC systems serving electronic equipment.
- b. Dehumidification. Cooling equipment provides effective dehumidification without the addition of special equipment. In locations where high humidity exists most of the cooling season, effective humidity control can be achieved by limiting fresh air intake (not below the outside air requirement for space occupancy) and exhaust; and sizing compressors for continuous operation; driving coil temperatures lower to remove excess moisture in the air; and by providing an air sealed room environment for critical electronic equipment. Dehumidification using reheat coils is acceptable in electronic equipment rooms, but should not be necessary when the requirements of paragraph 218.c.2) are maintained.

237. SEISMIC RESTRAINT. All HVAC systems and equipment shall be installed in accordance with IBC and SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems.

238. THERMOSTATS. A thermostat should be provided for each zone or zone combination serving a conditioned space. Multiple location temperature sensors shall be used in tower control cabs and TRACONs. Zones should be comprised of spaces with similar environmental control requirements. Thermostats should be specified that control heating and cooling modes separately.

a. Where there is a wide variance in temperature set points for heating and cooling, provide dead band thermostats. Thermostats controlling VAV air terminal units shall allow for throttling of the box dampers in response to room temperature. Thermostats should be tamperproof with keyed setting devices.

b. Locate thermostats and humidistats where they will measure the best average condition in a zone. Locate thermostats away from direct sunlight, heating or cooling sources, or exterior walls.

239. CAB WINDOWS. The capability to keep the tower cab windows free of condensation in all weather conditions; e.g., rain, frost, sleet, snow, dust, condensation, etc., shall be provided. The window washing method may be automatic or manual. Caution, water treatment system shall consider cab window wash-down system. See paragraph 151 for window glass requirements.

240. EXPANSION. Even though most ATCT/TRACON facilities are designed for a specific activity level expected within ten years, the potential for future expansion is often quite high. A close examination of the feasibility of the future HVAC system expansion shall be made after existing requirements are met. The designated approval authority through the FAA- approved studies and forecasts review shall determine the future requirement magnitude. Elements, which will expand within the facility, should be designed into the initial system. Major building additions would most likely require separate systems suited to the addition. The design, through future expansion piping taps use, chiller sizing, and shut-off valves to minimize cooling system disruption, shall incorporate adequate expected future expansion diversity. Mechanical equipment oversizing shall be limited to 15 percent.

241. VACUUM CLEANING SYSTEM. A central vacuum system shall be installed to serve the control cab and TRACON. Consideration should be given to include all electronic areas and, secondly, all administrative space in the area served by the central vacuum system. Due to noise considerations in normally occupied areas, the blower unit should be installed in a remote location. The central vacuum system should include built-in fire stop devices to prevent smoke from entering the cab.

242. HVAC SYSTEMS AND EQUIPMENT. Selection of appropriate HVAC equipment will require an in-depth analysis of facility loads and will depend upon the type and size facility. The designer shall consider the installation, operation and maintenance (O&M) costs of the different systems. Some general guidelines are offered for designer review.

a. Selection of HVAC systems shall be analyzed for economic payback based on original installation compared to cost to operate and maintain the system with a payback period of seven years being acceptable. For example, if a cooling tower is an additional \$50,000 more than an air cooled system but saves \$15,000 per year in energy costs; the payback period is $\$50,000/\$15,000$ per year = 3.3 years. Since 3.3 years is less than seven years this is an acceptable alternative.

b. Chilled Water Systems. These systems are acceptable for large facilities. Controls should allow for economizer cycle, air purge cooling, heat recovery during normal operation, and/or evaporative cooling where climate permits. Air and water-cooled chiller may be used.

1) In selecting these systems, consideration shall be given to the pump operating cost and cooling tower fans (if water cooled chillers are used) that are not currently being used in other systems. Consideration shall also be given to primary/secondary, bypass, and reverse return piping configurations for the chilled and condenser water, if used.

2) A drawback to chilled water systems is the additional floor space cost required to house chillers and pumps and the additional space required for the installation of cooling towers on site.

3) In climates where temperatures drop below freezing, heat tape shall be provided on the chilled water piping as appropriate.

4) Corrosion protection shall be provided for all chilled and condenser water piping.

c. Direct Expansion System. These systems are generally simple to operate and maintain, compact, reliable and minimize space-related problems. Select systems that are modulating, with multiple compressors or unloading type compressors. One problem that these systems present is that the package systems or condenser shall be located outside and near the conditioned space.

d. Constant Volume, Multi-zone. This is an acceptable method since these systems are more efficient than other constant air volume systems. Avoid systems that make use of reheat. Constant volume systems are generally the systems of choice when constant ventilation is necessary and heat reclaim is used.

e. Computer Room Air Conditioning (A/C) Units. Small constant volume, multiple units, mounted on raised floor, in or adjacent to electronic equipment rooms are the prime method of maintaining close temperature, humidity and pressure control in electronic equipment rooms with a raised floor. For electronic equipment rooms without raised flooring, this same close control of humidity and temperature can be achieved by installing Computer Room A/C units in rooms adjacent to the electronic equipment rooms, and ducting the supply air to serve the equipment rooms.

1) These constant air volume A/C units shall be used in electronic equipment areas requiring high sensible cooling with dehumidification and humidification requirements.

2) Air conditioner units mounted in the raised floor system shall have turning vanes and a control damper for more even air distribution.

3) The condenser section may be either glycol cooled, chilled water, or direct expansion (DX). In raised floor applications, these units shall also be provided with a leak detection system under the raised floor for electronic equipment protection.

f. VAV, Induction Systems. This is the easiest of all VAV systems to install and operate and is generally the most efficient for administrative and office applications. Directing return air movement is critical.

g. System Control. Efficient control types for varying air volume are variable frequency drive (VFD) fan speed control, controllable pitch fan blades, and inlet guide vanes (IGV). Flow measuring stations may be considered on large air handling units to guarantee supply air, minimum ventilation intake. If possible, avoid specifying scroll control and system bypasses, as these are relatively inefficient. Use of pneumatic or solid state electronic controls is acceptable; however, due to their electrical compatibility with the environmental control and monitoring system (ECMS/DDCS), solid-state controls are preferred.

h. Heating System. Select heating system and fuel source based on availability, economy, and life cycle costs. High-pressure boilers are not acceptable. Specify equipment with the highest energy efficiency for the system type selected. Interlock boilers with outside air temperature sensors. Reheat systems may be used as the site conditions deem necessary for dehumidification cycle.

i. Perimeter Heat. This system shall be considered for facilities in severe winter climates and/or when large window areas close to the floor have been incorporated into the building envelope. The radiation should be controlled so as not to conflict with the room HVAC system. Give special consideration to air noise in office areas.

j. Building Pressure. Design system pressures as low as practical. Space static pressures should be as close to atmospheric as possible with slight favor to overpressure, particularly in electronic equipment areas.

k. ECMS/DDCS. The ECMS/DDCS is used to start/stop HVAC equipment, limit electrical demand and shed electrical load, optimize HVAC functions, monitor alarms and log operation data, issue reports and provide equipment historical alarm/maintenance records.

l. Microprocessors with energy conservation software, remote communications capability, equipment sensors and controls, maintenance history, and training capability for new employees are generally available with state-of-the-art ECMS/DDCS.

m. The ECMS/DDCS computers power connection shall be determined by Order 6950.2.

1) The ECMS/DDCS shall consist of a central control and monitor computer to monitor and control, for energy conservation, each major building component, major HVAC system and subsystem; and should be located in a secure office space (generally the maintenance supervisor's office) near the mechanical equipment room or electrical room.

2) The ECMS/DDCS computer shall provide the status (kWh/kVA, peak kW) of

electrical power for the critical bus, essential bus, building service bus (non-essential) and E/G.

3) The ECMS/DDCS shall provide all building alarms and on-off indicators for system status, supply air temperature, outside air temperature, mixed air temperature, economizer cycle, energy source, pumps, exhaust and supply fans, critical louvers, and dampers, etc., as appropriate.

4) Controls necessary for the operation of the HVAC system and electrical system should be available through the computer.

5) Designers shall consider digital building management systems; these systems shall be an "open system" design that does not rely on an individual manufacturer's proprietary software or hardware.

6) All set points and alarm functions should be fully adjustable from the computer keypad. Generally as a minimum, alarm functions should be provided for smoke detector and manual fire alarm activation, sump pump failure, failure of primary or standby fan and refrigeration systems where dual sources are required, building security alarms, and out of tolerance filter loading differential pressure. Electronic Equipment Room (computer room air-conditioners) HVAC equipment shall be controlled directly by the ECMS/DDCS.

7) These A/C systems shall provide the alarm functions mentioned above and also HI /LO relative humidity, HI/LO temperature, compressor failure, and optional access floor water detection as a minimum.

8) When critical equipment/services are involved, locate sensor panels where personnel are normally stationed to hear and/or see alarm annunciation signals; otherwise, consider remoting a common light and/or sound-type alarm to a normally occupied area.

n. Solar Photovoltaic, Solar Lighting, and Heating.

1) Solar heating can be cost effective under certain circumstances and should be evaluated carefully. For ATCT/TRACON facilities, prior to specifying solar collectors the designer should establish that there is a significant heating load to satisfy, solar collectors (including photovoltaic (PV)) can have the correct orientation without shading, the system will be cost effective, and system reliability and maintenance will not be appreciably degraded. Consider photovoltaic electrical panels and solar lighting, via windows, mirrors, and light ducts.

2) Active water media collectors should be avoided. Passive air and active air media systems are generally more acceptable. These systems are currently being extensively used by industry and should be considered in regions where they have been determined beneficial.

o. Economizer Cycles. HVAC economizer cycle utilization shall be dependent on site geographic region location.

1) Where economizer cycles are being used, HVAC systems shall be equipped with appropriate economizer cycles and enthalpy controllers to provide for "free cooling" with outside air, except for all critical and under floor computer areas. The economizer cycle operation shall

not require the humidifiers use during very dry air intake periods. These humidifiers will consume more energy than saved by shutting down compressors. When an economizer is used, a cutoff switch shall be provided in the tower cab.

2) The control system should lock out either the economizer cycle or humidifiers with enthalpy controls, during uneconomical periods of operation. Additionally, manual lockouts should be provided on economizers for use when outside air contains unwanted pollutants such as pollen, petroleum fumes, and dust.

243. ENERGY CONSERVATION. The designer should use ASHRAE 90 for guidance in developing an energy efficient design for ATCT/TRACON buildings. Refer to paragraphs 20 and 113 for additional guidance on energy conservation.

CHAPTER 8. PLUMBING DESIGN

SECTION 1. INTRODUCTION

244. GENERAL. Plumbing in an ATCT/TRACON facility normally involves only a few specific minimum requirements that are more rigid than those utilized in most office buildings. This chapter presents the minimum requirements and special equipment needed at most ATCT/TRACON facilities. Piping shall be kept clear of cable tray access.

245. REFERENCES. The plumbing and fire protection references in Appendix 1 represent the minimum standards required for ATCT/TRACON facilities.

246. RESERVED.

SECTION 2. PIPING REQUIREMENTS

247. CAST IRON PIPE. All below-grade sanitary and storm sewer piping to five feet outside of exterior wall and/or foundation shall be standard weight, bell and spigot with push-on neoprene gasket, cast-iron or ductile iron pipe. All above ground interior sanitary sewer and storm sewer piping shall be no-hub, standard-weight cast iron or ductile iron, or D-W-V copper pipe. Vertical pipe in the tower shaft shall have expansion fittings sized per the height involved. PVC piping may be considered for above ground sanitary sewer and storm sewer piping.

248. COPPER PIPE. All above-grade hot and cold domestic water pipe shall be Type-L, hard-drawn, copper pipe. Use Type-K copper tubing for underground water supply.

249. PLASTIC PIPE. Plastic pipe schedule 40 and schedule 80 may be used, where appropriate, in accordance with ANSI standards.

250. NOISE ISOLATION. Where noise problems are critical, use shock absorbent, flexible connections, special mounting, or hangers.

251. CONTROL CAB DOWNSPOUTS. Piping for downspouts from the control cab roof shall be installed inside the control cab roof support column and shall be Type-L or Type-K soft-temper copper. Flexible stainless steel drain lines may be necessary and used only if there is no ability to use Type-L or Type-K soft-temper copper. Refer to paragraph 252 for additional installation requirements.

252. INSULATION. In cold weather climates, all domestic hot and cold water piping, roof drain hubs, water storage tanks, and downspout piping shall be insulated with fiberglass insulation with a vapor barrier.

a. The insulation, for the downspout pipe within the control cab roof support column shall be 1/2-inch-thick foam rubber with the remaining tube void filled with foam insulation. It should be noted that the control cab structure tube configuration produces a significant interior space limitation.

b. Provide electrical heat tapes and insulation for water pipes where required. Heat tapes shall include thermostat control with visual indicator for "ON" condition. Where possible, provide 18 inches minimum heat tape clearance access all around. Heat tape shall not be used on fire protection piping.

c. Fire protection piping shall not be exposed to freezing conditions. All fire protection runs shall be located within heated spaces.

253. SEISMIC RESTRAINT. All plumbing and fire protection systems shall be installed in accordance with IBC and SMACNA.

254.- 255 RESERVED.

SECTION 3. FIXTURES

256. CONTROL CAB. The control cab for all ATCT/TRACON facilities shall have a compact refrigerator; sink with bubbler, and water cooler. The sink shall be stainless steel with satin finish.

257. BREAK ROOM. ATCT/TRACON facilities containing break rooms shall have one or more appropriately sized refrigerators, sink, garbage disposal, microwave oven, and stove/range unit with filtered hood, vented to exterior. Break room access shall be in accordance with FED-STD-795 requirements. See paragraph 119.d.2) for cooking equipment installation requirements.

258. TOILET ROOMS. Vitreous china fixtures shall be used in all rest rooms. Flush valves shall be used on ground or second-floor only. Tank-type fixtures shall be used above the second-floor elevation. Chair mounts shall be used whenever possible. Provide disabled fixtures specified in paragraph 121 and required by FED-STD-795 for disabled access. Lavatories in tower restrooms should consider instant hot water heaters when the domestic hot water source is located unusually far away. Water conserving closets (1.6 gallons per flush) and urinals (1.0 gallon per flush) should be considered in design.

259. SERVICE SINKS. Mop sinks in janitor's closets should be floor type. Other service or utility sinks may be floor mount or wall mount and constructed of fiberglass, or cast iron enameled material. Provide each sink with wall-mounted faucets with vacuum breaker, and hose connections. Service sinks should not be designed for the hazardous cleaning materials disposal.

260. HOSE BIBBS. Hose bibbs with vacuum breakers (backflow preventors) shall be provided at ground level around the perimeter of the building and at the cab walkway level. All exterior hose-bibbs subject to freezing conditions shall be freeze proof type.

261. AUTOMATIC LAWN SPRINKLER SYSTEM. Automatic sprinkler systems for maintenance of landscaping and lawns should be installed wherever there is grass or landscaping to be watered.

262.- 266. RESERVED.

SECTION 4. SPECIAL REQUIREMENTS

267. CONTROL CAB. Emphasis shall be placed on assuring that no plumbing fixtures or piping will interfere with the functional cab use. Additionally, the domestic water supply shall be designed to prevent stagnant water at the control cab.

268. WATER PRESSURE. At ATCT locations where the main water service pressure is not sufficient to provide at least 30 psi at the top of the tower, a storage tank water pressure system with a booster pump shall be installed. Two booster pumps shall be installed when additional pressure is required. A primary pump shall be used for normal operation with a standby pump connected. The changeover operation shall be accomplished automatically. The complete pressure system shall have automatic operation capabilities. Design the pump system for minimum pump horsepower. Tower water, when pumped, shall be rated 150 psig at the pump. Seismic and/or thermal expansion joints shall be installed where appropriate.

269. FUEL STORAGE TANKS.

a. Where applicable, liquid propane pressure piping shall be installed in accordance with NFPA 58, LP-Gas Code, Order 1050.15, Fuel Storage Tanks at FAA Facilities, and Order 1050.16, Implementation Guidelines The storage tank shall be 250 psi single wall and approved for liquid petroleum gas (LPG). Use LPG tanks only in geographic areas where feasible.

1) All diesel underground storage tank (UST) installations shall be in accordance with Orders 1050.15 and 1050.16 for Compliance With Underground Storage Tanks, NFPA 50 and state and local codes. The fuel storage tank shall be located so that easy access is permitted. Flexible fuel lines shall be installed through exterior walls.

2) All above ground storage tank installations shall be in accordance with Order 1050.15 and NFPA 30, Flammable and Combustible Liquids Code, and comply with state and local codes.

b. Fuel tank capacity shall be of sufficient size to allow 72 hours, minimum, continuous E/G operation and boiler back-up fuel operation.

270. SANITARY TREATMENT. Connection to local sanitary sewer systems is recommended at all ATCT/TRACON facilities. In cases where connection is not possible, the design shall include a storage or treatment system. The system to be utilized shall be approved by the designated approval authority after consultation with appropriate local, state and Federal

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agencies. When these techniques are used, precaution shall be taken to ensure against possible contamination of domestic water supply system.

271. SUPPLEMENTARY WATER HEATING. In keeping with energy conservation policies, the ATCT facility base building designer should investigate solar energy feasibility for domestic hot water heating and building heating. Prior to implementing these techniques, operation impact, equipment redundancy, equipment reliability, initial, and operational costs shall be assessed. The designated approval authority shall approve the cost assessment methodology.

272. STORM DRAINAGE. Connection to local storm sewer drainage system is recommended at ATCT/TRACON facilities.

273. FOUNDATION DRAINAGE. Use the geotechnical report data to design the drainage system.

SECTION 5. FIRE PROTECTION

274. EXTINGUISHING SYSTEMS. Provide automatic fire extinguishing systems in accordance with the requirements of paragraph 102.

275. FIRE HYDRANTS. It is good practice to locate the ATCT/TRACON facility in proximity to an existing fire hydrant or provide a new hydrant onsite. A new hydrant shall be installed onsite if adequate existing mains are within 500 feet of the site. To reduce installation costs, combination domestic water supply/fire hydrant supply should be considered.

276. RESERVED.

CHAPTER 9. ELECTRICAL DESIGN

SECTION 1. INTRODUCTION

277. GENERAL. The criteria set forth in this chapter include the ATCT/TRACON facilities interior and exterior electrical systems minimum functional and design requirements. The power distribution system and components shall meet overall power system and critical occupying system reliability requirements. Power distribution system deviation waiver requests shall be presented for approval by ATB-320.

278. CODES AND STANDARDS. Electrical designs shall be in accordance with the electrical codes and standards listed in Appendix 1. Standby power systems shall be determined and installed in accordance with Order 6950.2. Other electrical orders, standards and specifications that provide guidance are listed in Appendix 1.

279. DISTRIBUTION SYSTEMS. The electrical systems addressed in this chapter include, but are not limited to, the following:

- a. Exterior Systems.
- b. Building Services.
- c. Wiring.
- d. Panelboards, Switchboards.
- e. Lighting and Wiring Devices.
- f. Grounding, Lightning, and Surge Protection.
- g. Emergency Lighting.
- h. Security Systems.
- i. Fire Alarm Systems.
- j. Telephones.
- k. Cable Trays.
- l. Engine Generators.
- m. DC Power Systems.
- n. Motor Control.

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- o. UPS.
- p. Local Area Network (LAN).
- q. Fiber Optic Cables.

280. RESERVED.

SECTION 2. EXTERIOR DESIGN

281. SITE LIGHTING Site lighting shall be designed and installed in accordance with Order 1600.6.

a. The site lighting design shall include photocell control for parking and walkways used 24 hours per day. Parking lots used only partially during evening hours shall be controlled by a photocell and time switch, connected in series so that lighting can be turned off during selected hours.

b. All sign lighting should be controlled with the same time controls used for adjacent lighting. These lighted areas shall permit safe vehicular and pedestrian maneuvering.

c. The design for these areas shall limit the ambient light on the control tower cab windows to no more than 0.1 foot-candles and shall be in accordance with the guidelines set forth in the Illuminating Engineering Society (IES) of North America's Reference and Application Handbook. Further minimum guidance on the lighting intensities is as follows:

- 1) Roadway. 0.6 to 2.0 foot-candles average maintained (with 3-1 uniformity).
- 2) Parking Areas. 0.6 to 1.0 foot-candle average maintained (with 4-1 uniformity).
- 3) Walkways. 0.6 foot-candle maximum.
- 4) Obstruction Lights. See paragraph 294.f.
- 5) Lighting sources should be compatible with adjacent lighted areas; i.e., if roadways to ATCT are lighted with high pressure sodium (HPS) or metal halide, that source should be used for site lighting and roadway lighting.

282. BUILDING SERVICE FACILITIES

a. Arrangements shall include the determination of whether the utility company or the user will provide the service transformer. Preferably, the utility company will provide the transformer; however, the final decision shall be based on the most economical method, and local power company policy.

b. The preferred service transformer should be delta primary, 480 volt wye; three-phase secondary with neutral and equipment ground at the service disconnect which should be located as close as possible and optimally, no more than ten feet from the transformer. Exact distance is determined by the building design.

c. Delta primary is preferred to reduce certain utility harmonics which improves the overall power quality supplied to the ATCT. A service transformer delta primary is required for new construction and required, subject to a cost/benefit analysis, for modernization projects.

d. Feeder voltage drops should be no more than 2 percent under the actual connected load conditions that serve sensitive electronic loads or associated power conditioning equipment.

e. Branch circuits voltage drops serving sensitive loads should be less than 1 percent of the feeder line voltage.

283. COMMERCIAL SUPPLY. Incoming feeders shall be single or dual, conform to Orders 6030.20 and 6950.2, and meet utility power quality requirements as defined by the ANSI/CBEMA voltage criteria (see IEEE-STD-1100). The utility harmonic limits shall meet IEEE STD 519 harmonic limit requirements. The incoming feeders exterior to the building shall be coordinated with the utility company's source. The feeders shall enter the building underground. When dual feeders are required, these feeders shall be taken from two separate sources and shall be run in separate ducts. When utility power quality is unable to meet FAA power quality requirements, the facility power design shall correct deficiencies to meet these FAA power requirements.

284. ELECTRICAL CONDUITS. Electrical designs should consider below grade conduit installations where possible. Designer should also consider water infiltration risk with below grade installations. FAA-C-1391, FAA-STD-032 and FAA-STD-019 provide guidance on conduit.

SECTION 3. BUILDING DISTRIBUTION

285. SERVICE DISCONNECT MEANS. The secondary side of the service transformer shall terminate, in accordance with NEC Section 230-70, in a separately mounted circuit breaker. The service disconnect means is also permitted to be a separately mounted fusible safety switch or a fusible panel board with a main fusible switch.

a. Ground Fault Interruption Protection. Ground fault interruption protection shall be provided in accordance with the NEC, and additionally, provide single-phase voltage loss protection where required. Ground fault interruption protection on the main distribution panel (MDP) will include a main circuit breaker with ground fault interruption protection.

b. Single Phase Loss Protection. When using fuse disconnects, down line electrical distribution shall provide single-phase voltage loss protection to any sensitive electronic equipment.

c. Nameplates and Identification. Panel nameplates and identification shall be installed in accordance with FAA-C-1217.

286. MAIN DISTRIBUTION PANEL (MDP).

a. The MDP shall be located in a room or space dedicated for such equipment in accordance with NEC.

1) This panel will normally be rated 480 volt, 60 Hertz, three phase, three wire and shall be designed with a minimum 25 percent spare capacity.

2) A short circuit calculation and protective device coordination analysis for the entire facility shall be accomplished to determine the appropriate available interrupting current capacity (AIC) requirement for all facility panels and breakers. This analysis shall be performed in accordance with Order 6950.27, Short Circuit Analysis and Protective Device Coordination Study.

3) The design shall be such that only the over current device closest to the fault will operate. Provide ground fault interruption protection option on all solid-state 480-volt breakers rated 225 ampere three-phase or higher with appropriate interrupt capacity. See paragraph 285 concerning ground fault interruption protection requirements.

b. The main distribution panel, essential (MDPE) will normally be rated 480 volt, 60 Hertz, three phase, three wire. This panel shall be designed with a 25 percent, minimum, spare capacity. All breakers 225 ampere three-phase and higher shall be installed in accordance with the NEC, have ground fault interruption protection option and be rated to provide interrupting capacity in accordance with the short circuit study.

c. Facilities with automated radar computer equipment will have an electrical power distribution system selected and installed in accordance with Order 6950.2. When an ATCT/TRACON facility requires a critical power distribution system (CPDS), the electrical design shall be coordinated with AOS-1000. AF P 6980.02, Project Implementation Plan, for the Critical Power Distribution Systems, **Figure 5-xx**, shows representative electrical one-line diagrams.

d. Only 480 volt, three-phase, wye, three wire distribution systems shall be used, based on their superior harmonic resolution capability. This capability is applicable to all size ATCT/TRACON facilities unless 480 volt, three-phase utility power is not available and a waiver is approved by ATB-320. The electronic equipment requires 120/208-volt service, and will generally be supplied from transformers 15 kVA to maximum 75 kVA (480 volt delta, 120/208 volt wye). Follow guidelines in IEEE STD 1100, the Federal Information Processing Standard (FIPS) power distribution publication for electronic equipment, and actual equipment loads to size transformer.

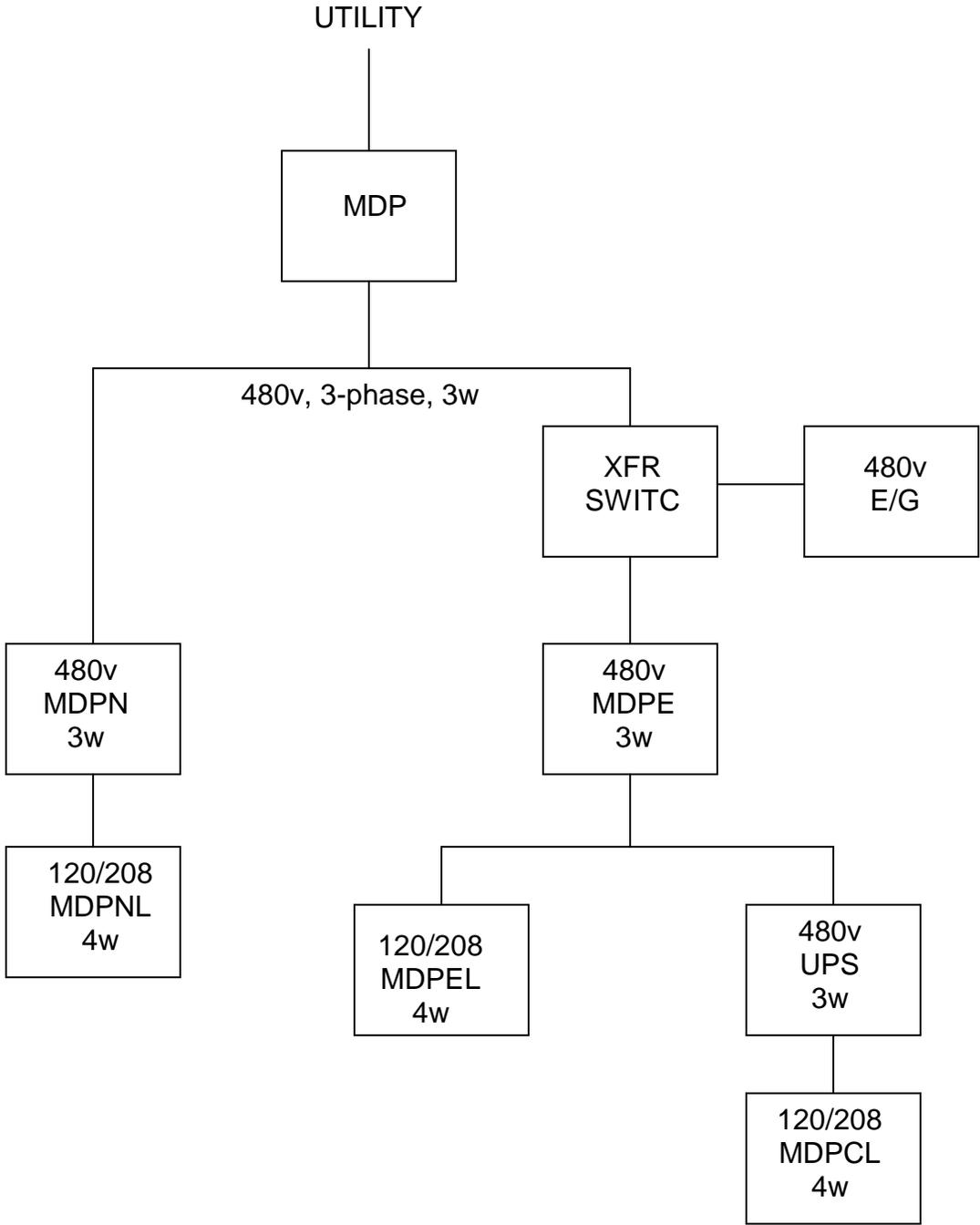


FIGURE 9-1 ELECTRICAL DISTRIBUTION SYSTEM

287.PANELBOARDS/SWITCHBOARDS.

a. Panelboards for building loads will normally be rated 480 volt; 60 Hertz, three-phase, three or four wire, and have interrupting capacity rated breakers sized in accordance with the short circuit study. The building loads shall consist of the following:

- 1) Motors 1/2 hp and larger - 480 volts, three phase.
- 2) Motors less than 1/2 hp - 120 volts, single phase.
- 3) Fluorescent lighting - 277 volts high efficiency type, except in dimming applications and where cost savings can be achieved in low quantity fixture applications. If it is determined that 277 volts would not provide better service, a lower voltage system may be considered.
- 4) High intensity discharge (HID) lighting; i.e., Mercury vapor, high pressure sodium or metal halide – 120, 208, 277 or 480 volts
- 5) Convenience outlets - 120 volts.

b. Panelboards for FAA electronic equipment shall be rated 120/208 volts, 60 Hertz; three phase, four-wire; and correct interrupting capacity rated breakers. Final breaker interrupting capacity shall be based upon the short circuit study and analysis conducted in accordance with Order 6950.27. When the building has normal and emergency power sources, these panels shall be connected to the essential or critical main distribution panel.

1) Panelboard doors shall be installed in accordance with FAA-C-1217. All phase, neutral and grounding bus within the electrical panels shall be copper and all connectors shall be Underwriters Laboratories (UL) listed for copper. Panel schedules shall be completed and installed in accordance with FAA-C-1217.

2) The following rooms or equipment types in new designs with 277/480 volts available, should have individual panel boards with appropriate size, 480 volt delta to 120/208 volt wye transformer located within 10 feet, where feasible, that serve only the electronic load in that room or of that type:

- a) Cab.
- b) Communications Equipment Room.
- c) Radar/ARTS Equipment Room.
- d) TRACON Operations Room.
- e) Telco Room.
- f) Communications and Radar Workshop.
- g) ASDE Equipment.

- h) RML/TML Equipment.
- i) ECMS/DDCS Equipment.

3) Isolation transformers rated up to 150 kVA with 208V/120 secondary normally will have less than 10 kA available fault current. Panel boards can generally use less costly breakers with 10 kAIC interrupting capacity rating. The actual circuit loading should dictate the isolation transformer minimum size.

c. Switchboards may require solid-state circuit breaker type with ground fault interruption protection option, when rated over 225 amps, three phase. Required studies and design dictate actual devices used. Provide breakers with interrupt rating in accordance with the short circuit study. See paragraph 285 for additional fault current design guidance and short circuit and protective device coordination study requirements.

d. All panel boards shall be designed with 25 percent spare main capacity and additional installed breakers. The panelboards and switchboards shall be provided in such a configuration so that spare circuit breaker space should exist for each power type on a system basis; i.e., building service, essential, and critical systems. The spare circuit breakers shall be distributed and exist in every panelboard/switchboard.

e. Fuses in lieu of circuit breakers are allowed in instances where complete protection device coordination in the critical systems cannot be obtained using other protection devices.

288. STANDBY POWER SYSTEMS.

a. Facility standby requirements are determined in accordance with Order 6950.2. E/Gs shall only be purchased under the National Engine Generator ordering procedures established and monitored by AOS-1000.

1) An E/G standby power system shall consist of an essential main distribution panel (MDPE) connected to the commercial power system through the MDP. The E/G set may only be provided as government furnished equipment (GFE). The E/G set consists of an E/G, automatic transfer switch, load bank, day tank and associated accessories.

2) The main fuel tank is purchased separately from the E/G.

3) In the event of utility power failure and an automatic transfer to the emergency source, the E/G shall provide power to critical, essential and life safety loads.

4) It is permissible to connect the administration area loads to the essential bus as long as the engine-generator is not sized for the additional load. This load shall have a shunt trip if the engine-generator is 100 percent loaded for a period of 4 minutes. This load will be disconnected if there is a possibility of interrupting operations and maintenance loads.

5) Separate conduit not containing power wires, shall be provided for installing control and monitor cabling to the E/G. Conduit shall be installed in accordance with FAA-C-1217.

6) The E/G shall be monitored from the AT operational (TRACON and/or cab) area.

7) The designer is responsible for confirming the required size of the E/G with the designated design approval authority. The E/G size is based on calculated connected facility load, spare capacity growth and FAA-STD-032 requirements. When sizing the engine-generator, use a demand factor of 0.8 for electronic loads and mechanical loads.

8) The E/G fuel choice shall meet local and Federal EPA environmental requirements.

9) E/G sizing and system accessory information is provided on the Engine Generator Program web site. The AOS-1000 web site also has on-line complete E/G system ordering information.

b. Uninterruptible Power Source (UPS). When required, an UPS shall be provided and physically located by the designer to regulate and provide quality power to critical electronic equipment. UPS equipment shall only be purchased through the AOS-1000, UPS Program Office.

1) The UPS normally consists of a primary AC power source, rectifier/battery charger, batteries, static inverter, maintenance by-pass switch and static transfer switch. The UPS shall be designed to provide uninterrupted, continuous power for critical equipment between failure of commercial power and E/G start up and to protect equipment against damage or failure from transient voltages from the utility service.

2) Critical electronic equipment power back-up requirements are defined in Order 6950.2.

3) Battery installation requires special attention to ensure that the load distribution does not exceed floor design limit (refer to paragraph 168). Batteries require sufficient environmental control to maintain ambient temperatures between 65 and 77 degrees F. Consider the latest battery technology when selecting battery cell type.

4) The UPS equipment and battery areas require adequate ventilation or space conditioning to control the heat dissipated from the equipment cabinet and, if required, to exhaust any gases or odors that might be released in the event that a battery enclosure is fractured.

5) The UPS, with required battery monitoring, is installed in series with commercial power and standby E/G and continuously feeds branch panels serving critical automation equipment.

6) The UPS design should provide maintenance load bank capability. The load bank can be part of the power distribution system or a maintenance connection available to use a portable load bank.

c. Power Conditioning Systems (PCS). A PCS is useful in controlling abnormal voltage and transient voltage conditions that may originate from a poor quality power source. A PCS is authorized in accordance with Order 6950.25.

289. MOTORS AND MOTOR CONTROLS. Provide overcurrent protection in the combination starters and disconnects or circuit breakers feeding the motors. Use high efficiency motors only. Motor sizes commonly used in ATCT/TRACON facilities should have efficiency ratings between 85 and 90 percent. Motor controls and disconnecting means shall be installed in accordance with FAA-C-1217. All motors shall be controlled by one of the following methods:

- a. Magnetic type starters for three-phase systems.
- b. Manually with thermal element for single-phase systems.
- c. Reduced voltage type for large motors and compressor motors when they exceed 20 percent of the supplying transformer capacity.
- d. Variable frequency drives (VFDs).

290. TRANSFORMERS. Dry-type, K-rated transformers shall be provided to power electronic equipment from the 480 volt, three-phase, three-wire source. The transformers shall be sized no larger than 75 kVA and located as close as possible to the electronic load in accordance with IEEE STD 1100, rated 480 delta to 208/120Y volts, 60 hertz, three phase, four wire, and designed for non-linear loads. Dry-type transformers used indoors shall be copper windings, energy efficient, quiet type with standard National Electrical Manufacturer's Association (NEMA) taps and meet IEEE STD 1100, FAA-C-1217 and FIPS 94 recommendations. Minimum transformer K-rating shall be K-13.

291. WIRING METHODS. All wiring and conduit shall be installed in accordance with FAA-C-1217 and the NEC.

- a. Conductors for discrete control wiring shall be No. 14 AWG minimum, No. 16 AWG minimum for analog control and shall always be in a separate conduit.
- b. Cables in tray systems located in return air plenums shall not be over 600 volts and have a flame-retardant jacket and cable rated and listed for return air plenum installations.
- c. THHN/THWN wiring insulation is preferred for electrical system ceiling lights in control cab. Other type wiring in accordance with the NEC and specific lighting situations are authorized.
- d. The designer shall consider a fiber optic network control system for tall ATCTs after completing, and based on the results of, a cost benefit analysis (CBA). The ATCT fiber optic network shall be a two-node network consisting of main and standby equipment. The minimum fibers installed shall be a 24 single-node and a 24 multi-node per cable. Cables shall be installed over two spatially diverse routes. The four basic fiber optic interface types that shall be provided are a) Telephone Industry (encompassing DS-1, DS-0 and ISDN), b) discrete process and control, c) Ethernet and d) video.

292. CAB DC POWER SYSTEM. Certain FAA solid state equipment or traffic control light-guns in ATCTs not equipped with an E/G will require a nominal 12 or 24 volt DC electrical

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power supply in accordance with Order 6950.2. The DC power system shall contain the following items:

- a. Modular Panel board, +/-24 volts DC/200 ampere, with capability to be reconfigured to +12 volts DC or -48 volts DC by using DC to DC converters.
- b. Distribution panels utilizing circuit breaker panel.
- c. Distribution AC to DC rectifiers, sized to supply DC power to the load and recharge the batteries within 12 hours following a four-hour operation of the batteries. The rectifiers shall be solid-state and type acceptable to the telephone and microwave industries.
- d. Battery system capable of sustaining equipment operation for four hours after commercial power loss.
- e. Battery disconnect panel utilizing 2-pole, 200 ampere circuit breakers.
- f. Local meter and alarm panel or local/remote monitoring system.
- g. System steady state voltage at the equipment shall remain between 22 and 28 VDC (float) when utilizing +/-24 VDC rectifiers, 11 and 14 VDC (float) when utilizing +12 VDC rectifiers, or 47 and 56 VDC (float) when utilizing -48 VDC rectifiers whether being energized by commercial power, from batteries alone, or during the transition period from commercial power to batteries.
- h. System steady-state voltage at the equipment shall remain at 12 VDC +/- 2V, whether being energized by commercial power, battery power or during a transition between commercial and battery power.
- i. Maximum DC system output ripple at the equipment feed shall not exceed 100 mV peak, when energized by commercial power without batteries.
- j. System Status and Control Panel that offers remote and local monitoring of the DC Power System as well as control functions.
- k. Consider providing a portable or mobile E/G connection where no installed engine is provided.

293. RESERVED.

SECTION 4. LIGHTING AND CONVENIENCE OUTLETS

294. GENERAL. Energy efficiency shall be considered in the lighting design. The design of interior lighting shall be coordinated with architectural room layouts and equipment room layouts and shall conform to the requirements listed in Table 9-1 and as follows:

- a. All fluorescent fixtures shall be solid-state design. EMI/RFI emitted by fluorescent light fixtures shall not interfere with electronic and computer equipment. Design to suppress radio frequency interference (RFI) and electromagnetic interference (EMI) related noise in the lighting system.
- b. Full spectrum fluorescent light fixtures may be used for lighting.
- c. Electronic ballasts shall have a total harmonic distortion less than 10 percent.
- d. Light switches shall be specification grade rated 20 ampere, 120 or 277 volts, single pole, three-way or four-way, as required by the circuit controlled.
- e. Lighting patterns and switching shall be designed for maximum energy efficient operation, including the consideration of infrared and motion sensing switching and two light level switching for each room.
- f. Obstruction lights shall be provided for all towers in accordance with Advisory Circular AC70/7460-1, Obstruction Marking and Lighting, and Federal Aviation Regulation (FAR) Part 77.
- g. Convenience outlets shall be specification grade rated 20 ampere minimum. Planning shall be accomplished to ensure that power outlets are convenient to work areas.
- h. Isolated ground receptacles shall be provided as required by specific equipment.
- i. Fluorescent lights on a separate circuit with keyed switch for cleaning illumination should be included in operational areas where low ambient lighting is required.
- j. All facility designs shall include energy efficient, glare reducing lighting. For energy conservation purposes, incandescent lighting shall be kept to a minimum.

295. TRACON OPERATIONS ROOM. Lighting intensities in the TRACON operations room are usually kept at a very low ambient level, less than 5 foot-candles (fc), in order to prevent glare and reflection detracting from the target viewing on the radar displays. The design shall consider incandescent lighting with pinhole covers or framing capabilities in lieu of fluorescent lights. These incandescent lights can be aimed exactly where needed and, unlike fluorescent lights, can be dimmed to low light levels.

- a. An acceptable lighting design for this space will maximize ambient lighting levels below console shelf height to provide good visibility for movement within the room. The light intensity should be uniform and approximately 10-15 fc. Above shelf height, the designer should minimize stray light sources and reflection which may appear as reflections on the displays.
- b. The designer and the architect should coordinate proper finish materials selection with surface texture and color that will complement the lighting design. In addition, provide separate fluorescent lighting circuit for maintenance and house cleaning as outlined in paragraph 294.i.

c. House cleaning lights should be connected to a keyed switch to prevent accidental turn-on.

d. Indirect fluorescent dimmer switch controlled lighting should be considered for low lighting requirements. All lighting should be on dimmer switches with circuits that permit zoned control. Provide dimming controls for lighting arranged in zones based on console configuration and usage. The high ambient light level should be less than 2 fc at the shelf for glare free radar displays. Install shields and filters around light sources and/or displays to mitigate sources of glare. Information for one type of light filter source can be viewed at <http://www.ergonomicaccessories.com/lighting>.

e. An alternate recommendation to be considered is incandescent lighting with pinhole covers or framing capabilities. This type light can be aimed exactly where needed and can successfully be dimmed to low light levels without flicker. The technical and operational need may outweigh the additional cost of the incandescent light higher energy consumption.

f. Ambient Lighting for TRACONS with Low Ceilings.

1) TRACONS with ceilings 8'-10' high should use indirect fluorescent cove lighting mounted to the wall perimeter. TRACONS with ceilings 10'-13' high should consider indirect cove lighting and/or indirect pendant lighting. Indirect pendant lighting requires adequate ceiling height to allow even distribution of light reflected from the ceiling. If it is determined that a lighting design using indirect lighting would not result in adequate glare reduction then deep can lights may be considered.

g. Ambient Lighting for TRACONS with High Ceilings.

1) Lighting for large TRACONS with ceiling heights above 13', should be modeled in general after the Display System Replacement (DSR) fluorescent lighting fixtures installed in the Air Route Traffic Control Centers (ARTCC). The indirect pendant light fixtures must be positioned low enough below the ceiling to allow even distribution of light reflected from the ceiling, but high enough to provide adequate clearance for personnel safety. Indirect cove lighting mounted to the wall perimeter may also be used.

h. Light Fixture Baffles.

1) Provide light baffles to block the glare from a direct light source as needed. The baffles should be louvered so as not to obstruct operation of smoke detectors.

i. Supervisor's Console Lighting.

1) The lighting at the supervisor's consoles should not need modification. Most supervisor's consoles have and should continue to have self-contained lighting on a dimmer. The lighting fixtures are flexible such that the source can be aimed away from the scopes. Baffles are utilized here as well.

j. Position Lighting.

1) Typically, can lights (specular black finish, spots) or LED bezel lights with adjustable apertures exist over the positions. A dimmer usually controls the position lighting and shines directly down onto the writing shelf.

k. Floor Lighting. Under counter lighting and theater type floor lighting is used to light the floor between the aisles.

TABLE 9-1 LIGHTING REQUIREMENTS

ROOM	DESIGN (fc)	RECOMMENDED FIXTURE TYPE	REMARKS	EMERGENCY LIGHTING CIRCUIT REQUIREMENT
Office	50-75	Recessed Fluorescent	Fixtures may be air supply or heat extraction type. In large rooms, provide for switching zones. In spaces with windows, use fixture w/4 lamps and provide for switching ballasts separately.	Not Required
Clerk/Steno	50-75	Recessed Fluorescent		Not Required
Conference	30	Recessed Fluorescent		Not Required
Storage	10	Industrial Fluorescent		Not Required
Mechanical Equipment	50-70	Industrial Fluorescent		100% of Fixtures
Engine Generator	30-40	Industrial Fluorescent		50% of Fixtures w/one Battery Light
Communication Equipment	50-70	Recessed or Industrial Fluorescent	Switch Control each row of fixtures.	50% of Fixtures
Radar/ARTS Equipment	50-70	Recessed or Industrial Fluorescent	Switch Control each row of fixtures.	50% of Fixtures
Voice Switch/ Telco	50-70	Recessed or Industrial Fluorescent		50% of Fixtures
Break Room	30-50	Recessed or Industrial Fluorescent	Fixtures may be air supply or heat extraction type.	One Fixture
Locker	30	Recessed or Industrial Fluorescent		One Fixture
Toilets	20	Incandescent or Fluorescent	Use incandescent inlays not requiring continuous lighting.	One Fixture
Console Assembly Cable Access Level Cable Chase	10	Incandescent or Industrial Fluorescent	Fluorescent fixtures should have cold start ballasts in unheated areas. Lights should be individually switched.	50% of Fixtures
Stairways and Vestibules	20	Incandescent or Fluorescent	Lights should be individually switched.	100% of Fixtures on essential power and 100% battery operated fixtures back-up for egress while E/G is starting up.
Corridors	20	Recessed Fluorescent	Fixtures may be air	33% of Fixtures

ROOM	DESIGN (fc)	RECOMMENDED FIXTURE TYPE	REMARKS	EMERGENCY LIGHTING CIRCUIT REQUIREMENT
			supply or heat extraction type.	
PCS/UPS	50-70	Recessed or Industrial Fluorescent		50% of Fixtures on UPS, 50% on Utility Power

296. CONTROL CAB.

- a. An acceptable cab lighting design will
 - 1) Provide adequate lighting for movement within the cab under nighttime conditions.
 - 2) Provide sufficient task lighting at the consoles to permit writing and fine print reading.
 - 3) Prevent excess cab luminaries glare from appearing on the cab windows or instrument dials.
- b. Projector type framing lights for console desk illumination have been used with success as well as track lighting, museum type 2-inch diameter spot lights, theater lighting for floors, sharp cutoff spots for center room illumination, and back lighted displays for instrumentation (electro-illumination).
- c. All cab lighting shall be controlled by dimmer switches, and zoned by lighting type and location.

297. RADAR/ARTS EQUIPMENT ROOM. The room lighting shall be designed to provide glare-free illumination on the equipment surfaces. If fluorescent light fixtures are used, they shall meet paragraph 294.a requirements. Each fixture or bank of fixtures should have individual switches to control glare.

298. AIRFIELD LIGHTING CONTROL PANEL. Provisions shall be made in the cab console for the airfield lighting control panel. The airport authority should be notified as soon as possible so they can budget for the control panel relocation.

299. EXTERIOR HEATER OUTLETS. Provide watertight outlets for auto heaters in parking lots at cold weather sites when required by CHAPTER 4, paragraph 76.f.

SECTION 5. SPECIAL REQUIREMENTS

300. GROUNDING, LIGHTNING, AND SURGE PROTECTION.

a. Lightning protection, transient protection, grounding, bonding and shielding design shall be designed and installed in accordance with FAA-STD-019; FAA-STD-020, NFPA 780, Underwriters Laboratory 96A, Installation of Lightning Protection Systems, FAA-C-1217 and Order 6950.19.

b. The grounding system design resistance shall be as close to zero as possible and always measure 10 ohms or less as described below. The design shall consist of the following:

1) Earth Electrode System (EES). Building structural members shall be bonded to a Earth Electrode System (EES) consisting of a 4/0 copper counterpoise and ground rods.

a) The EES counterpoise shall be buried 2 feet below grade and encircle the building 2 to 6 feet outside the building perimeter. FAA-STD-019, paragraph 3.10.2 describes the soil resistivity measurement procedure. Additional guidelines are provided in Orders 6950.19 and 6950.20.

b) The EES counterpoise cable shall be exothermically welded to the minimum of four (4) ¾ inch, 10-foot copper or copper-clad steel ground rods. One ground rod shall be located at each corner of the EES. Rods shall penetrate below the frost line.

c) Additional rods for larger perimeter buildings shall be spaced at 2 to 3 times rod length (20 to 30 feet).

d) All underground metal objects such as pipes, telephone ground, tanks, etc., shall be bonded to the EES with a copper cable no smaller than # 2 AWG.

e) Access to the Earth Electrode System (EES) shall be provided through one or more access wells with removable access covers at each facility or site. Access wells shall be of non-conductive material and have a minimum opening of 175 square inches. Installation shall be accomplished in accordance with Order 6950.19, paragraph 19.

f) Potential equalization shall be accomplished in accordance with NFPA 780, paragraph 5-8.1.

2) Multi-point ground system. All metallic non-current carrying parts of electrical and mechanical equipment throughout the system shall be bonded with two separate ground straps of unequal length and connected to the multi-point ground system.

a) The multi-point ground system is a multi-path, low resistance ground for equipment racks, building structural steel, steel enclosures, cable trays, square duct, all air conditioning ductwork, frames, equipment cabinets, raceways, wire ways and cable ladders.

b) Multi-point ground systems shall be installed in locations throughout the building in accordance with FAA-STD-019, so that all items that are required to be multi-point grounded can easily be connected to a well labeled, clear plastic protected, multi-point ground plate. The combination of a raised floor with a signal reference grid (SRG) is a type of multipoint ground system referred to as an equipotential plane. Where this type grounding is used, there is no requirement for labeled, clear plastic protected ground plates. Connections are made to either the

SRG or the raised floor stringers and pedestals.

c) Multi-point grounding conductors are to be insulated and color-coded green with orange tracers. The multi-point ground system shall be separate (isolated) from the single-point ground system except at the main ground plate where both systems are connected.

d) The main ground plate and multi-point ground plates shall be clearly labeled, clear plastic protected, and located for easy access to, a SRG when installed in conjunction with a raised floor, lower floor steel columns, and to above ground metallic water pipe, where available. When used, the SRG is the multipoint ground.

e) All structural members such as building columns, wall frames, roof trusses of steel frame buildings and other metal structures shall be made electrically continuous by bonding each joint and interconnection. They shall be bridged with a brazed or welded # 4/0 stranded copper cable. The structural steel shall be bonded to the EES with a bare, # 4/0 AWG stranded copper cable.

f) All metallic electrical raceway systems shall be bonded and electrically continuous throughout their length. In addition, an equipment-grounding conductor shall be installed along with feeder and branch circuit conductors in each raceway.

g) The building concrete reinforcing bars (rebar) shall be incorporated into the building grounding system.

h) An FAA standard signal reference grid is required under all raised floors. Where installed, the SRG shall be connected to the building steel, and to the underground counterpoise surrounding the building. See FAA-STD-019 with references to ANSI/IEEE STD-1100. See paragraph 124.e.

i) All above ground and interior metallic cold water piping systems shall be bonded to the service disconnecting means ground point or directly to the EES. The bonding jumper shall be sized in accordance with the NEC.

3) Single-Point Ground (SPG) System. Provide a separate single-point ground system in accordance with FAA-STD-019, paragraph 3.12 for electronic equipment requiring an isolated ground. Building single point grounds are not required unless installed electronic equipment requires an isolated ground.

a) The single-point ground system is to be used as an isolated signal reference. This system shall be installed as a trunk-branch system of plates that are clearly labeled and with labels protected by clear plastic; and shall consist of insulated green conductors with yellow tracers.

b) The single-point ground system shall be separate (isolated) from the multi-point ground system except at the main ground plate, where both systems are connected. Single point grounds are never daisy-chained together.

c) A single point ground plate shall connect to the main grounding plate with a

single copper cable in accordance with FAA-STD-019.

d) At least one (1) single point ground plate should be installed on each equipment level in the tower shaft when required.

4) Communications Separately Derived Source. Provide communications equipment grounding by separately derived sources in accordance with FAA-STD-019.

a) To assure good high frequency grounding during normal operation, a low impedance connection must be provided to the EES. A main ground plate shall be established at the lowest junction level beneath the cab. All grounding systems present at or above this level shall be connected to this main ground plate. Installation of ground plates shall comply with FAA-STD-019 requirements.

b) Isolation transformers, connected as a separately derived source, should be installed for all circuits including those HVAC and lighting circuits operated at 277/480V. TVSS devices, rated in accordance with IEEE STD-62.41 and UL listed, shall be connected at the isolation transformer output. The bonding jumper, sized in accordance with the NEC, from the isolation transformer secondary neutral shall be grounded to the transformer enclosure and terminated at the main power ground bus at the lowest equipment level.

c) Communication and other antennas located on top of the ATCT shall have their axial lines fed through bulkhead plate at the lowest equipment level. This bulkhead plate, along with any other surge/transient suppression elements permitting a separate ground, shall connect to a suppression ground plate located at the lowest equipment level in close proximity to the main grounding plate and connected to the main grounding plate with a 500 kcmil insulated copper cable color coded green with a red tracer.

d) The tower top protected envelope shall have all inputs re-referenced, isolated or protected with a combination of these previously described techniques.

5) Power Cable Tray Grounding Conductor Support in Tower. A wide copper strip affixed to the cable tray for the power conductors shall form the basis for the grounding system for the upper levels of the ATCT. This grounding system shall be installed in accordance with FAA-STD-019, paragraph 3.9.12.2.

a) Two separate 500 kcmil cables exothermically welded to the plate and to the EES shall ground the copper main ground plate. It should be terminated upon entry to the lowest equipment level in the tower shaft at a main grounding plate. The main power should be connected to this main grounding plate with a cable sized in accordance with the NEC requirements.

b) Additional grounding cables shall be run to the EES in close proximity to the copper strip and bonded to it at 20-foot intervals. These additional cables, if required, shall connect to the main grounding plate at the lowest equipment level in the tower shaft. This close cable proximity to the copper strip is required to minimize the inductive pickup loop from the top to the bottom of the ATCT.

6) Signal Reference Grid. The multi-point grounding system shall include signal reference grids (SRGs) composed of thin flat copper strips laid in an interconnected grid pattern. This grid pattern shall be installed under all equipment and operational areas.

a) SRGs on individual floors at the top of the tower shall be interconnected in at least 4 widely separated locations by wide thin copper strips totaling no less than 2 feet in combined width between any two adjacent floors.

b) The widely spaced low impedance interconnection will help to maintain all SRGs at the same voltage potential.

c) Ideally, the SRG should be located below a raised floor and interconnected with the raised floor at every third support.

d) The copper strips are sized in accordance with FAA-STD-019.

e) An alternative is to mount the SRG on the ceiling and connect it from the floor above. Connecting to an overhead SRG is unacceptable as it causes a high level of lightning sensitivity.

f) All equipment cabinets or racks containing a multi-point ground bus shall be connected to the SRG with two cables whose length differ by at least 20 percent of the shorter cable length. The two conductors should be terminated to the same point on the equipment and SRG. The double connection, with unequal length conductors, of all cabinets to the SRG ensures that if one cable is in resonance at a given frequency, the other cable will not be resonant at that frequency.

g) Interconnecting cables used for connecting the cabinets or racks shall be no smaller than #6 AWG and sized to provide at least 2000 cmil/foot of run (refer to Table 9-2). A six (6) inch perimeter strip shall be used to minimize differences in potential around the periphery of the SRG.

7) Telephone Company Ground. Provide a 2/0 cable exothermically welded to the earth electrode system in the telco room for telephone company equipment. Minimize the cable length and route directly to the earth electrode as possible.

TABLE 9-2. PERMITTED LENGTHS FOR INTERCONNECTING GROUND CABLE

AWG	kcmil (MCM)	Permitted Length (ft)
6	26.24	13
4	41.74	20
3	52.62	26
2	66.36	33

Note: Single point ground systems shall originate from the main ground plate established in accordance with Paragraph 300b4).

8) Lightning Protection System. A lightning protection system shall be provided for all ATCT/TRACON facilities to protect sensitive equipment from damage by lightning surges, and prevent personnel injury and property damage.

a) Two (2) copper lightning down conductors, minimum, shall be installed outside the ATCT structure in accordance with FAA-STD-019. The building size and shape developed during the design process will determine the total number of down conductors.

b) Properly protected control tower structures may be considered to have a zone of protection in accordance with NFPA 780.

c) The base building portions extending beyond the protection zone shall be adequately protected with an independent lightning protection system in accordance with FAA-STD-019.

d) The lightning protection system shall be designed to protect at a striking distance of 150 feet. It shall consist of lightning protection air terminals, roof and lightning down conductors, equipotential loops with horizontal air terminals on the shaft, transient protection for AC power service and control cables, and an EES as described above.

e) There shall be a minimum of two (external building structure) paths to the EES from each air terminal.

f) Lightning down conductor bonding shall be by an exothermic weld directly to an EES ground rod.

g) Additional paths may be added when considering building size and shape.

h) Lightning down conductors shall be bonded to building steel in accordance with FAA-STD-019 and NFPA 780.

i) Equipotential loops shall be installed in accordance with NFPA 780.

j) Lightning protection components are not allowed in the antenna raceway.

9) Surge Protection System.

a) Surge protection shall be provided on the line side of the main service switch.

b) Transient/Surge suppression devices should be installed where telco lines, land-lines, or control cables enter or leave the ATCT, at the secondary of any separately derived source, and at the AC power service entrance to the facility.

c) Transient suppression devices for telco lines, land lines, and control cables shall be installed using an "A" Bus (High Energy) and "B" Bus (Low Energy) system. The "A" Bus shall be exothermically welded to a ground rod of the EES with a #4 AWG insulated green wire with red tracer. The "B" bus should be connected to the multi-point ground system with a #6 AWG insulated green wire with orange tracer or to the equipment grounding conductor with a #6

AWG insulated green wire.

d) See FAA-STD-019 for additional communications and audio lines transient and surge protection.

301. EMERGENCY LIGHTING. Emergency lighting shall comply with Paragraph 106 and additionally, consist of the following:

a. For towers without E/Gs the emergency lighting shall be battery pack lights provided as follows:

- 1) Exits, corridors, and stairs illumination.
- 2) Interior spaces housing critical electrical and mechanical equipment.
- 3) Critical areas housing electronic equipment.

b. For towers with E/G the emergency lighting shall be as follows:

- 1) Battery pack lights in the E/G and electrical rooms.
- 2) Space luminaries connected to the emergency power circuits in the cab, radar and communication equipment rooms, E/G room, TRACON (spots and floor lights only), electrical/mechanical room, break room, stairways and lavatory in accordance with paragraph 294, Table 9-1.
- 3) Exit corridors and vestibules shall have sufficient general building luminaries connected to the emergency system to provide emergency exit illumination.

302. SECURITY SYSTEMS. Security system design shall be completed in accordance with Order 1600.69. The Security System shall be powered from the critical bus or a small UPS installed for the security system.

a. ATCT/TRACON facilities security systems will vary according to the security category code assigned by the initial security survey conducted by the servicing security element in the development process data collection phase.

b. All facilities generally will separately control internal access to critical functions and access through an employee entrance using an access control system.

c. There shall be adequate security devices; e.g., remote closed circuit television (CCTV) cameras with remote door release, to allow admittance verification and entrance in accordance with current FAA policy.

d. Security systems for ATCT/TRACON facilities may include automatic gate control with card reader and/or cipher lock door control, electric strike controlled entry or CCTV at entries.

e. Provide electric strike door control at visitor's entry.

f. Provide security entry control at the control cab, TRACON and employee entrance.

g. Provide an intercom via the building telephone system or security lock system at building entries. Refer to paragraphs 24 and 79 for additional security requirements.

303. FIRE ALARM SYSTEM. The fire alarm system shall consist of heat sensing and ionization smoke detectors, manual alarm stations, and control panels.

a. The ionization smoke detectors shall be located in the mechanical and electrical rooms, electronic equipment rooms, storage rooms and any other areas considered a probable fire source.

b. Manual alarm stations shall be provided in cab, shaft, and any base buildings at exits in accordance with CHAPTER 5.

c. The control panel should be located at the main entry with a remote annunciator at the cab and/or TRACON room. The control panel shall announce an alarm with activation of any alarm station or detector and be capable of shutting down air handling equipment. The control panel shall notify the local fire department in accordance with paragraph 101.n. Refer to CHAPTER 5 for additional considerations.

304. LOCAL AREA NETWORK AND FIBER OPTIC CIRCUITRY. Provide future cable installations for local area network and fiber optic circuitry. The designer shall consider the installation of cable trays to accommodate the future installation of LAN and fiber optic lines to satisfy signal and control requirements between the ATCT, TRACON, and other portions of the facility as appropriate. Specific guidance shall be obtained from the designated approval authority.

305. CABLE TRAYS. A cable tray raceway system, with a depth of four inches, shall be provided for electronic and telephone equipment. The cable trays shall be designed to provide shielding consistent with equipment cabling requirements and UL listed where possible. The system design shall be coordinated with specific equipment layouts as directed by the designated approval authority. Do not locate cable trays in fire rated corridors and exits. Cable trays shall be easily accessible for maintenance. Where feasible, cable tray installations shall provide 12 inches access between trays and 36 inches access around trays. Cable trays shall be bonded in accordance with the NEC.

306. LABELING. Make provisions for labeling of all distribution panels, control equipment, and conduit feeders. Label equipment with permanent marking as identified on plans and feeders should be labeled with service voltage. Distribution panels shall be labeled with their name, voltage and next breaker supply source.

307. METERING. Metering shall be provided in accordance with local utility standards.

308. TELECOMMUNICATIONS AND NETWORKS. Wiring for telecommunications and computer networks (voice/data/video), when specified by the designated approval authority shall conform to the EIA/TIA 568 requirements.

a. Telecommunications and network cables shall be specified to provide adequate bandwidth for the installed or planned networks. Cable performance categories listed in EIA/TIA TSB36 shall be used. Pathways and spaces for these systems shall conform to the requirements of EIA/TIA 569. The designer shall implement as part of the design, a cable management system using the EIA/TIA 606 guidelines. Category 5 LAN wiring shall be installed as a minimum. When not possible, use best commercial practices.

309. POWER AND COMMUNICATIONS OUTLETS. Power outlets and telephone, local area network (LAN) and National Radio Communications System (NRCS) jacks shall be convenient to work areas.

310. COMMUNICATION EQUIPMENT ROOMS. Communication equipment rooms shall be installed as close as possible to the antennas to reduce transmission loss.

311.- 315 RESERVED.

APPENDIX 1 REFERENCED PUBLICATIONS

FAA ORDERS

1050.1	Policies and Procedures for Considering Environmental Impacts
1050.15	Fuel Storage Tanks at FAA Facilities
1050.16	Implementation Guidelines for Compliance with Underground Storage Tanks
1050.18	Chlorofluorocarbons and Halon use at FAA Facilities
1050.19	Environmental Due Diligence Audits in the Conduct of FAA Real Property Transactions
1053.1	Energy and Water Management Program for FAA Buildings and Facilities
1100.126	Standard Organization of Air Traffic Control Terminal Facilities
1200.21	Intergovernmental Review of FAA Programs and Activities
1600.6	Physical Security Management Program
1600.69	FAA Facility Security Management Program
1600.54	FAA Automated Information Systems Security Handbook
1730.8	FAA Graphic Standards
3900.19	Occupational Safety and Health
4420.4	Space Acquisition (Historical Information Only)
4660.2	Accessibility of FAA Buildings to the Physically Handicapped
4660.5	Conservation of Energy in FAA Occupied Office Space and Buildings
4665.3	Policy on Parking Accommodations at FAA Occupied Buildings and Facilities
6000.36	Communications Diversity
6030.20	Electrical Power Policy
	Airport Traffic Control Tower Siting Criteria
	Maintenance of Terminal Air-To-Ground Communications Facilities
6480.8	Maintenance of Airport Traffic Control Towers

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6500.9	Maintenance of Back-up Emergency Communications (BUEC) Facilities
6510.4	Radio Communications Requirements for Air Traffic Control Facilities Maintenance of Weather Broadcast and Information Service Equipment
6560.13	Maintenance of Aviation Meteorological Systems and Miscellaneous Aids Maintenance of Communications Transceivers
6670.4	Maintenance of Multi-channel Recorder Equipment
6930.1	Fire Protection and Maintenance of Fire Protection Equipment
6950.2	Electrical Power Policy Implementation at National Airspace Systems Facilities
6950.17	Maintenance of Electrical Systems in Buildings
6950.19	Practices and Procedures for Lightning Protection, Grounding, Bonding and Shielding Implementation
6950.20	Fundamental Considerations of Lightning Protection, Grounding, Bonding and Shielding (Theory)
6950.27	Short Circuit Analysis and Protective Device Coordination Study
AF P 6980.02	Program Implementation Plan for the Critical Power Distribution Systems
6980.3	Plant Equipment Modification Handbook - Engine Generators
7031.2	Airway Planning Standard Number One - Terminal Air Navigation Facilities and Air Traffic Control Services

FAA STANDARDS

FAA-STD-002	Facilities Engineering Drawing Preparation
FAA-STD-003	Paint Systems for Structures
FAA-STD-004	Criteria for Selection and Installation of Fire Extinguishers
FAA-STD-005	Preparation of Specification and Standards
FAA-STD-012	Paint Systems for Equipment
FAA-STD-019	Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities
FAA-STD-020	Transient Protection, Grounding, Bonding and Shielding Requirements for Electronic Equipment

- FAA-STD-032 Design Standards for National Airspace System Physical Facilities
- FAA-STD-033 Energy Management in NAS Physical Facilities

FEDERAL STANDARDS

- FED-STD-595 Colors
- FED-STD-795 Uniform Federal Accessibility Standards
- DoT Publication Graphic Standards for the U. S. Department of Transportation

FAA SPECIFICATIONS

- FAA-C-1217 Electrical Work, Interior
- FAA-C-1391 Installation and Splicing of Underground Cables
- FAA-C-2256 Temperature and Humidity Control Equipment
- FAA-E-2214 Gun, Signal Light, Portable
- FAA-E-2229 Portable Signal Light Gun Reels
- FAA-E-2312 Console, TRACON/RAPCON Modular
- FAA-E-2470 Transparent Plastic Window Shades
- FAA-G-2100 Electronic Equipment General Requirements

FEDERAL SPECIFICATIONS

- FED-SPEC WW-C-563 Electrical Metallic Tubing (EMT)

FAA REPORTS

- ASP-75-4 Establishment Criteria for Airport Traffic Control Towers (ATCT)

CODE OF FEDERAL REGULATIONS

- 3 CFR 301 Intergovernmental Cooperation Act
- 10 CFR 435 Energy Performance Standards for Federal Residential or Commercial Buildings
- 10 CFR 436 Federal Energy Management and Planning Program
- 29 CFR 1910 Occupational Safety and Health Administration

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29 CFR 1926 Safety and Health Regulations for Construction

29 CFR 1960.20 Alternate Standard for Fire Safety in Airport Traffic Control Towers

36 CFR 1190 Architectural and Transportation Barriers Compliance Board

FAA ADVISORY CIRCULARS

AC 70/7460.1 Obstruction and Marking and Lighting

AC 150/5300-13 Airport Design

AC 150/5320-5 Airport Drainage

FAA MANUALS AND HANDBOOKS

Handbook 4660.1, Real Property Handbook

Graphic Standards for the Federal Aviation Administration

Acquisition Management System (AMS)

FEDERAL AVIATION REGULATIONS (FAR)

FAR Part 77 - Objects Affecting Navigable Airspace

FAR Part 107 - Airport Security

OTHER PUBLICATIONS

AASHTO - Interim Guide for Design of Pavement

American Concrete Institute (ACI) - Building Code Requirements for Reinforced Concrete and
Commentary (ACI 318)

American Concrete Institute (ACE) – ACI 530/ASCE 5/TMS 402

American Institute of Steel Construction; Manual of Steel Construction

American Iron and Steel Institute (AIS) Light Gage Cold-Formed Steel Design Manual

AWS D1.1, Structural Welding Code Steel

ASCE 7, Minimum Design Loads for Buildings and Other Structures

ASHRAE, Handbook of Fundamentals, Weather Data and Design Conditions

ASHRAE, Heating, Ventilating, Air Conditioning Guide

ASHRAE 15-1994, Mechanical Refrigeration Safety Code

ASHRAE 52.1, Dust Spot Procedures for Testing Air-Cleaning Devices

ASHRAE 62, Ventilation for Acceptable Indoor Air Quality

ASHRAE 90, Energy Conservation in New Building Design

ASHRAE 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

ASHRAE 100.5, Energy Conservation in Existing Buildings

ASME A17.1, Safety Code for Elevators and Escalators

ASTM A36, Standard Specification for Carbon Structural Steel

ASTM A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength (AASHTO M164)

ASTM A615, Standard Specification for Deformed and Plain Billet – Steel Bars For Concrete Reinforcement

ASTM C90, Standard Specification for Load bearing Concrete Masonry Units

ASTM E81, Standard Test Method for Preparing Quantitative Pole Figures

ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials

ASTM E648, Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

Building Officials and Code Administration International (BOCA), National Building Code Building Code Requirements for Masonry Structures

Department of Commerce (DoC), Bureau of Public Roads manual on Uniform Traffic Control Devices for Streets and Highways

Department of the Navy Design Manual, "Structural Engineering" (NAVFAC DM-2)

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APPENDIX 1

Department of Transportation (DoT) Manual, Uniform Traffic Control Devices for Streets and Highways

EIA TIA-568 - Commercial Building Telecommunications Wiring Standard

EIA TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces

EIA TIA-606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

EIA TIA TSB-36 - Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted Pair Cables

Energy Policy Act of 1992 - Public Law 102-486

Environmental Policy Act of 1969 - Public Law 91-190

Executive Order 12372 - Intergovernmental Review of Federal Programs

Executive Order 13123 – Greening the Government through Efficient Energy Management

FIPS Publication 94 - Guidelines on Power for Automatic Data Processing Installations

IEEE STD 141- (Red Book) IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (ANSI)

IEEE STD 142 - (Green Book) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (ANSI)

IEEE STD 241 - (Gray Book) IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (ANSI)

IEEE STD 242 - (Buff Book) IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (ANSI)

IEEE STD 399 - (Brown Book) IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis (ANSI)

IEEE STD 446 - (Orange Book) IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (ANSI)

IEEE STD 518 - IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources

IEEE STD 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

IEEE STD 739 - (Bronze Book) IEEE Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities (ANSI)

IEEE STD 1100 - IEEE Recommended Electronic Equipment Grounding Practice

Illuminating Engineering Society of North America Reference and Application Handbook

National Concrete Masonry Association (NCMA), Specification and Design Notes

International Building Code (IBC)

International Mechanical Code (IMC)

International Plumbing Code (IPC)

National Plumbing Code - Based on National Plumbing Code AS/A 40.8

NFPA 10 Standard for Portable Fire Extinguishers

NFPA 13 Sprinkler Systems Installation

NFPA 30 Flammable and Combustible Liquids Code

NFPA 37 Installation and Use of Stationary Combustion Engines and Gas Turbines

NFPA 58 LP Gas Code

NFPA 70 National Electrical Code (NEC)

NFPA 72 National Fire Alarm Code

NFPA 75 Protection of Electronic Computer/Data Processing Equipment

NFPA 80 Fire Doors, Fire Windows and Smoke-Control Door Assemblies

NFPA 80A Recommended Practice for Protection of Buildings from Exterior Fire Exposures

NFPA 96 Ventilation Control and Fire Protection of Commercial Cooking Operations

NFPA 101 Life Safety Code

NFPA 110 Emergency and Standby Power Systems

NFPA 780 Installation of Lightning Protection Systems

SMACNA - Seismic Restraint Manual, Guidelines for Mechanical Systems, Appendix E Seismic Design for Buildings U.S. Air Force Manual AFM 88-3

Steel Joist Institute Standard Specifications and Load Tables

UL96/96A, Lightning Protection Institute Standards

APPENDIX 2 DEFINITIONS

ADMINISTRATIVE SPACE. That space required for all administrative and personnel functions such as offices, lobbies, waiting rooms, conference rooms, training rooms, and break areas.

AIR TRAFFIC CONTROL SERVICE. Service provided by AT control specialists to insure the safe, orderly, and expeditious movement of aircraft or vehicles operating in the air operations area.

AIRPORT. An area of land or water, used or intended to be used for the landing and takeoff of aircraft, and includes its building and facilities, if any.

AIRPORT OPERATION. Either a landing or a takeoff at the airport. A low approach below traffic pattern altitude or a touch-and-go operation shall be counted as both a landing and a takeoff; i.e., two operations.

AIRPORT OPERATIONS AREA. As used in this order, the term airport operations area shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft, including such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.

AIRPORT TRAFFIC CONTROL TOWER. A facility established on an airport to provide air traffic control service on and in the vicinity of that airport.

AIRWAY FACILITIES. Equipment and building facilities that provide direct or indirect support to the control of air traffic. (Includes radar and communications systems, navigational aid equipment, back-up power systems, and HVAC systems.)

BASE BUILDING. The structure (usually attached to the base of a tower shaft) that houses ATCT facility support space.

CAB EYE LEVEL. Five feet above cab floor height.

CAB FLOOR HEIGHT. See Tower Height.

CONTROL CAB. A glass-enclosed observation cabin from which air traffic control specialists observe, communicate with, and control all airport traffic.

DESIGNATED APPROVAL AUTHORITY. The office or person with approval authority, as documented by formal correspondence, for a particular function or facet of activity or design.

DRAINAGE SYSTEM. The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted.

DROP TUBE. A tube through which flight data strips can travel from the control cab to the TRACON. Also called strip transfer tube.

EASEMENT. A conveyance of a limited interest in real property for a specific purpose. It may be granted for a specified term or in perpetuity. Normally, the owner of the property is permitted use of his property if it will not interfere with Government use.

FAA. The Federal Aviation Administration of the U.S. Department of Transportation. When used to designate a person, FAA shall mean the Administrator or his duly authorized representative.

FAST. The Federal Aviation Acquisition Management System Toolset.

FUNCTIONAL SPACE. All space utilized within the ATCT facility that contributes to its functional operation. Functional space includes any combination of all other space designations utilized and defined herein.

INSTRUMENT OPERATION. The arrival at or departure from an airport or an aircraft operating in accordance with an IFR flight plan or the provision of IFR separation from other aircraft by an ATC facility.

JUNCTION ROOM. The room or space in a tower shaft immediately below the control cab.

NON-FUNCTIONAL TOWER SHAFT. That portion of the ATCT that structurally supports the cab and has no space allocations for the performance of administrative or maintenance activities, nor any spaces allocated for the assignment of personnel.

OPERATIONAL SPACE. That space required for the daily operations at an ATCT facility. This space includes the control cab and TRACON operations room, when utilized.

SECTOR. A geographic region defined by the FAA for jurisdictional control of airway facilities.

SPONSOR. Any non-Federal agency, municipality, or other organization providing some economic backing for the development of an ATCT.

STRIP TRANSFER TUBE. See Drop Tube.

SUPPORT SPACE. That space required for maintenance activities within the ATCT facilities, which includes work on shop areas, tool, and part storage, as well as that space housing some of the miscellaneous working equipment.

TECHNICAL SPACE. That space required to house mechanical, electronic, and radar equipment in an ATCT facility.

TOWER HEIGHT. The vertical distance from the ground level to the cab floor.

TOWER SHAFT. The freestanding, vertical structure of an ATCT, that supports the control cab 40 to 300 feet above ground level (AGL), which may house HVAC systems, electronic equipment, administrative space, operation space, an elevator, and/or stairwell, etc.

TRACAB. Combines typical control cab operations with TRACON functions, in a cab, for low-activity radar facilities.

TRACON. Room containing equipment and personnel for the operating positions that control IFR traffic.

WAVE GUIDE. A special assembly of radio frequency cable that transmits, with very little loss, the energy received by radar.

XERISCAPE. Comprehensive water management approach to landscaping that is based on selecting, placing, and maintaining plants to optimize water use

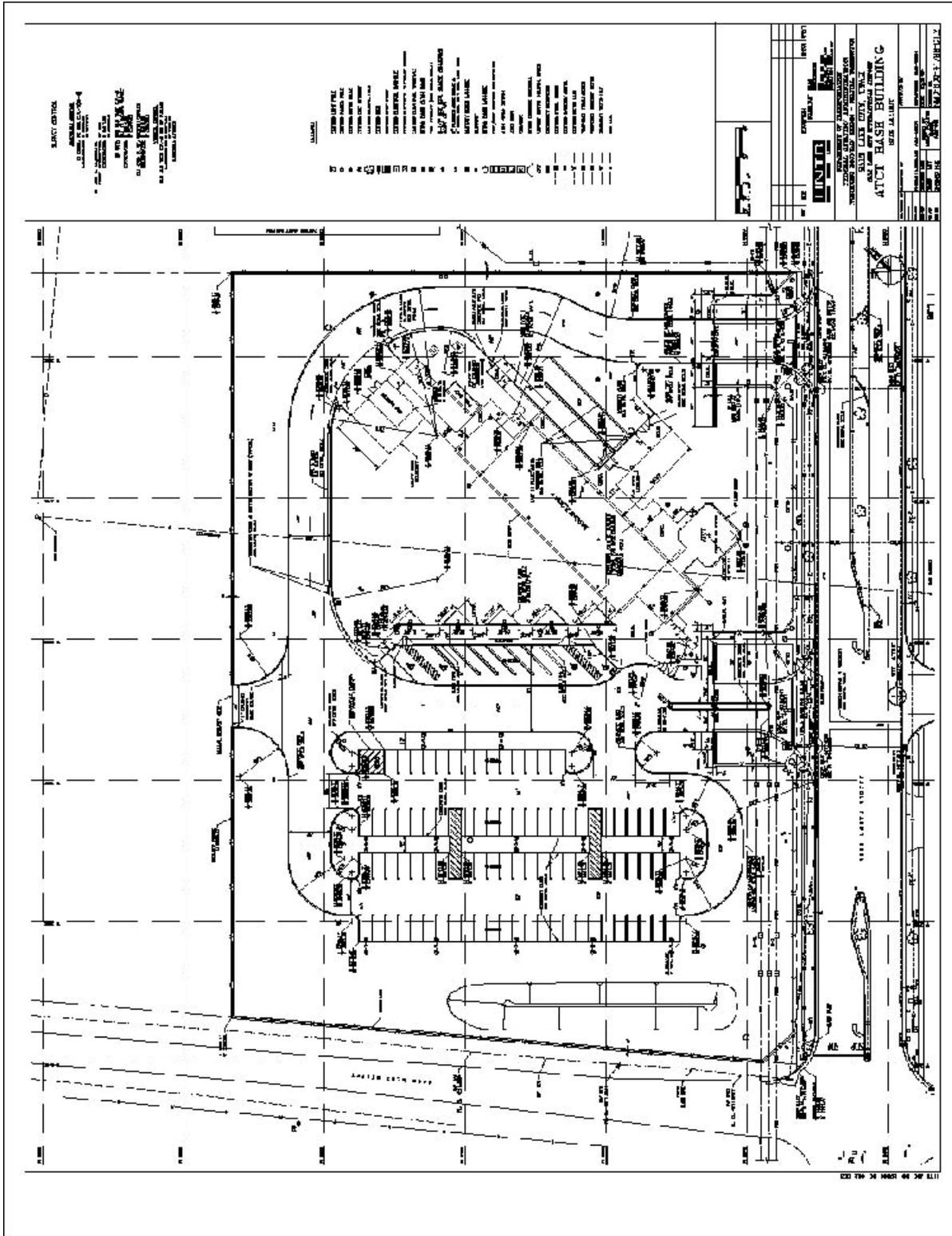


FIGURE 3. REPRESENTATIVE MAJOR ACTIVITY ATCT SITE LAYOUT

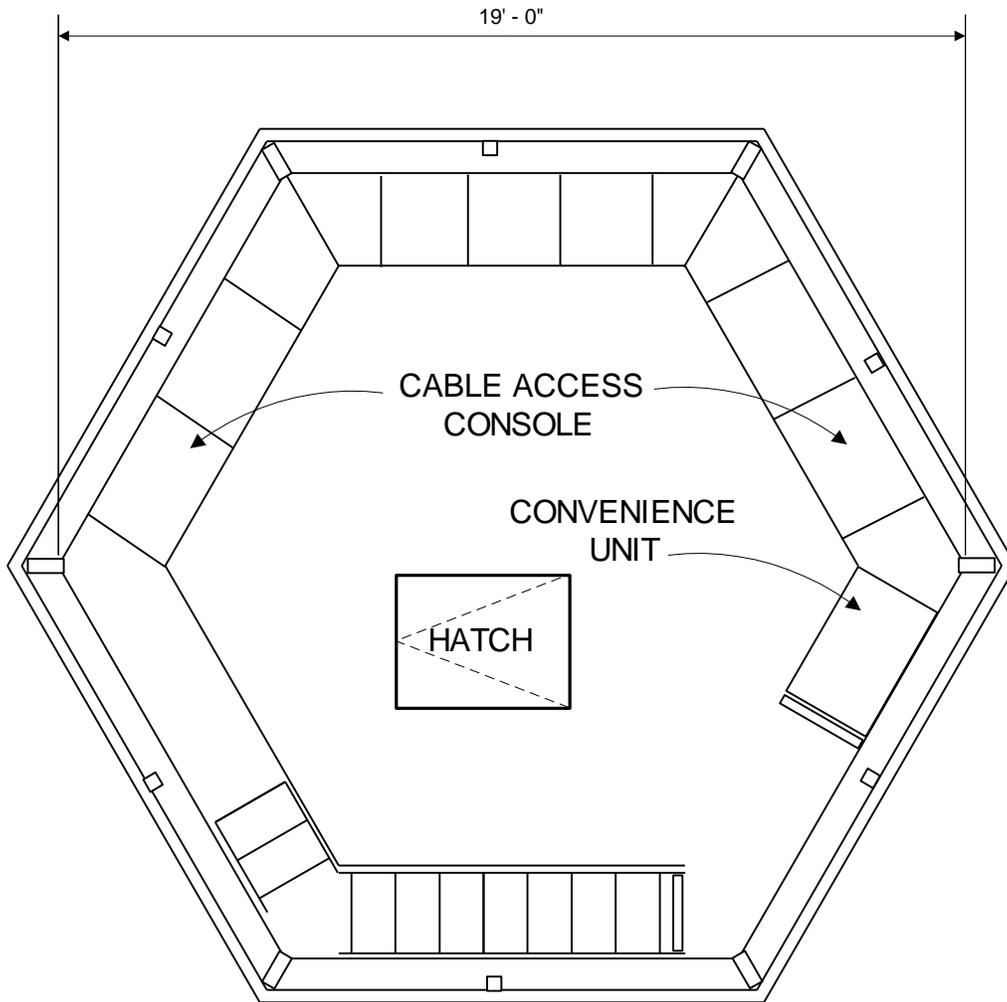


FIGURE 4. 234 SF STANDARD LOW ACTIVITY CONTROL CAB LAYOUT

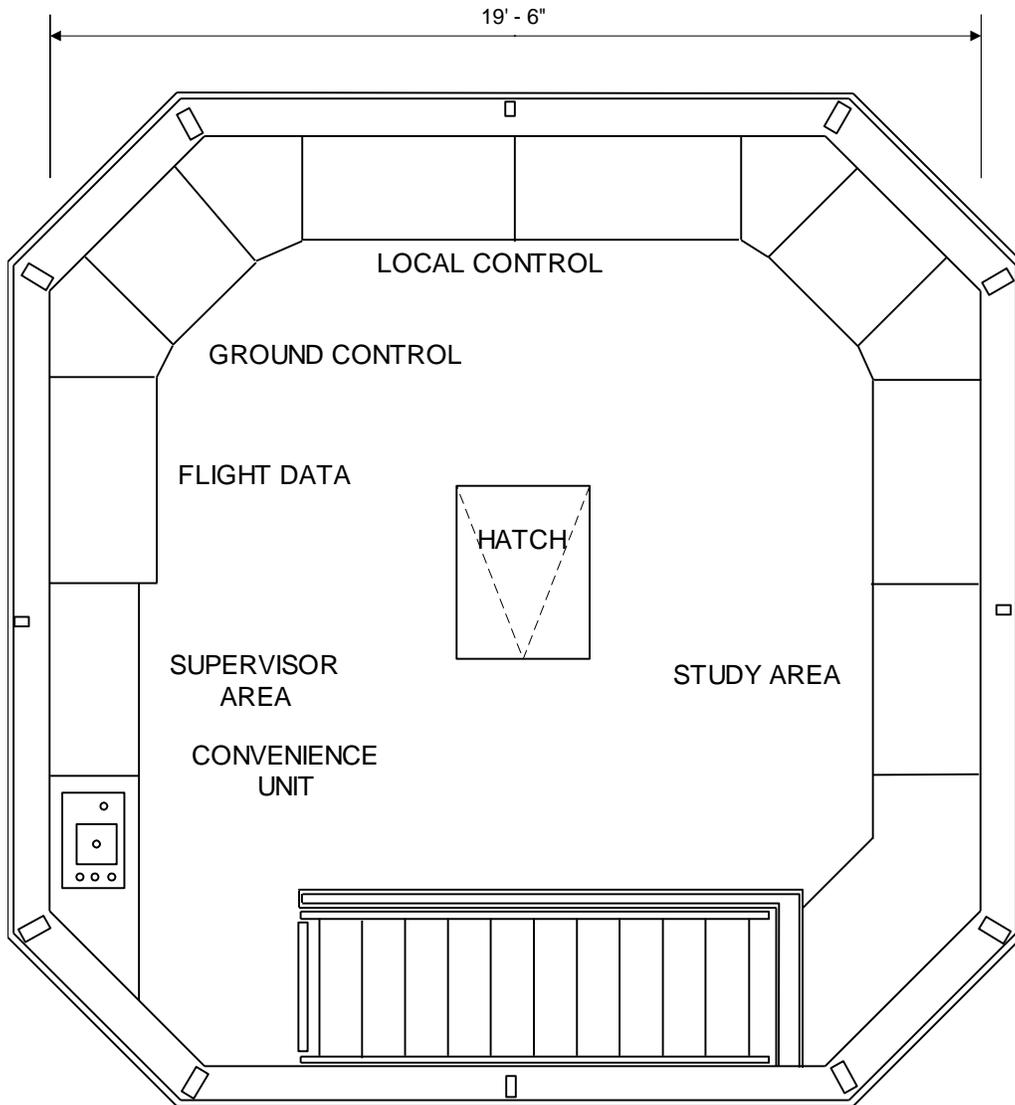


FIGURE 5. 350 SF STANDARD INTERMEDIATE ACTIVITY CONTROL CAB LAYOUT

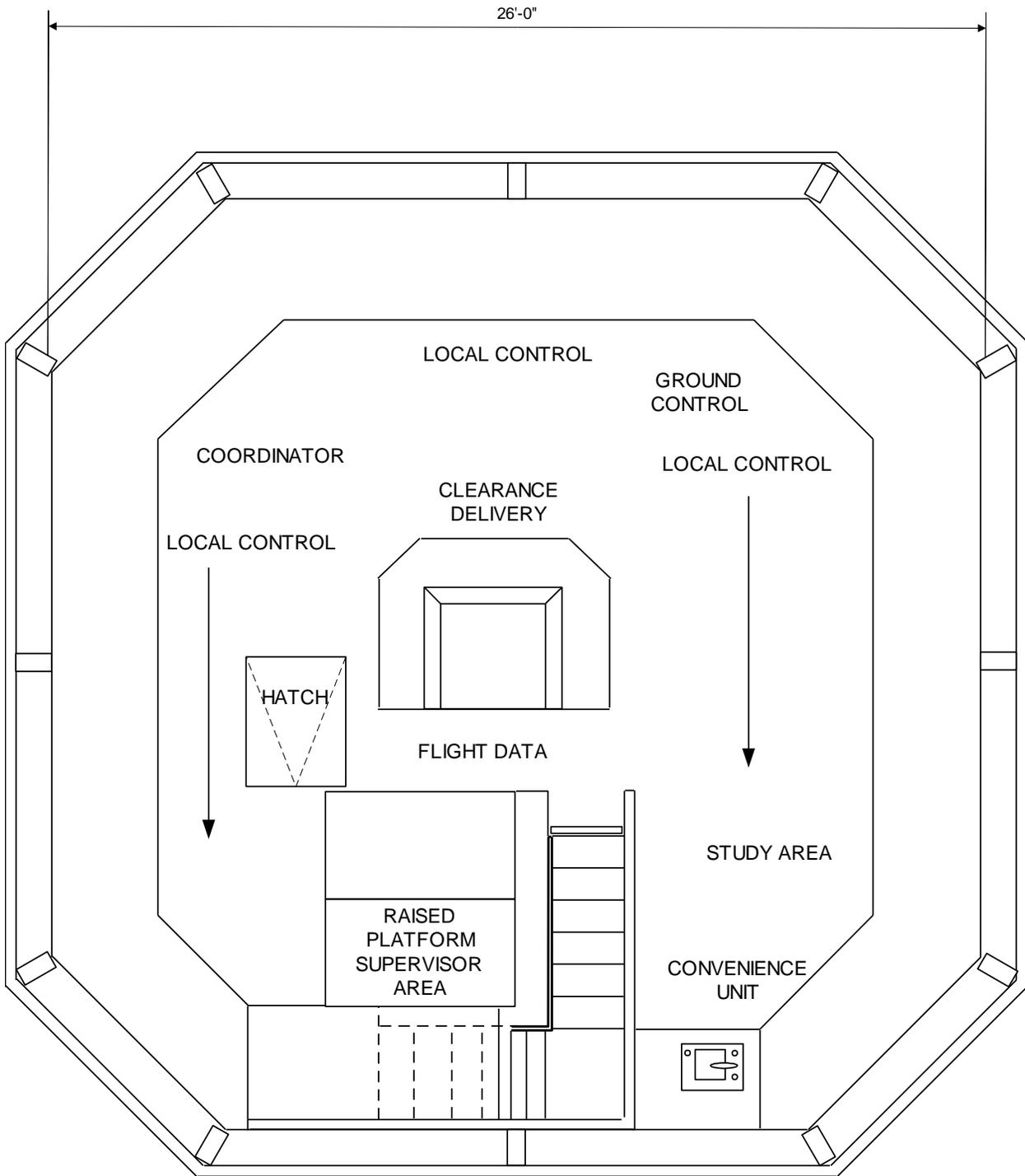


FIGURE 6. 625 SF STANDARD MAJOR ACTIVITY CONTROL CAB LAYOUT

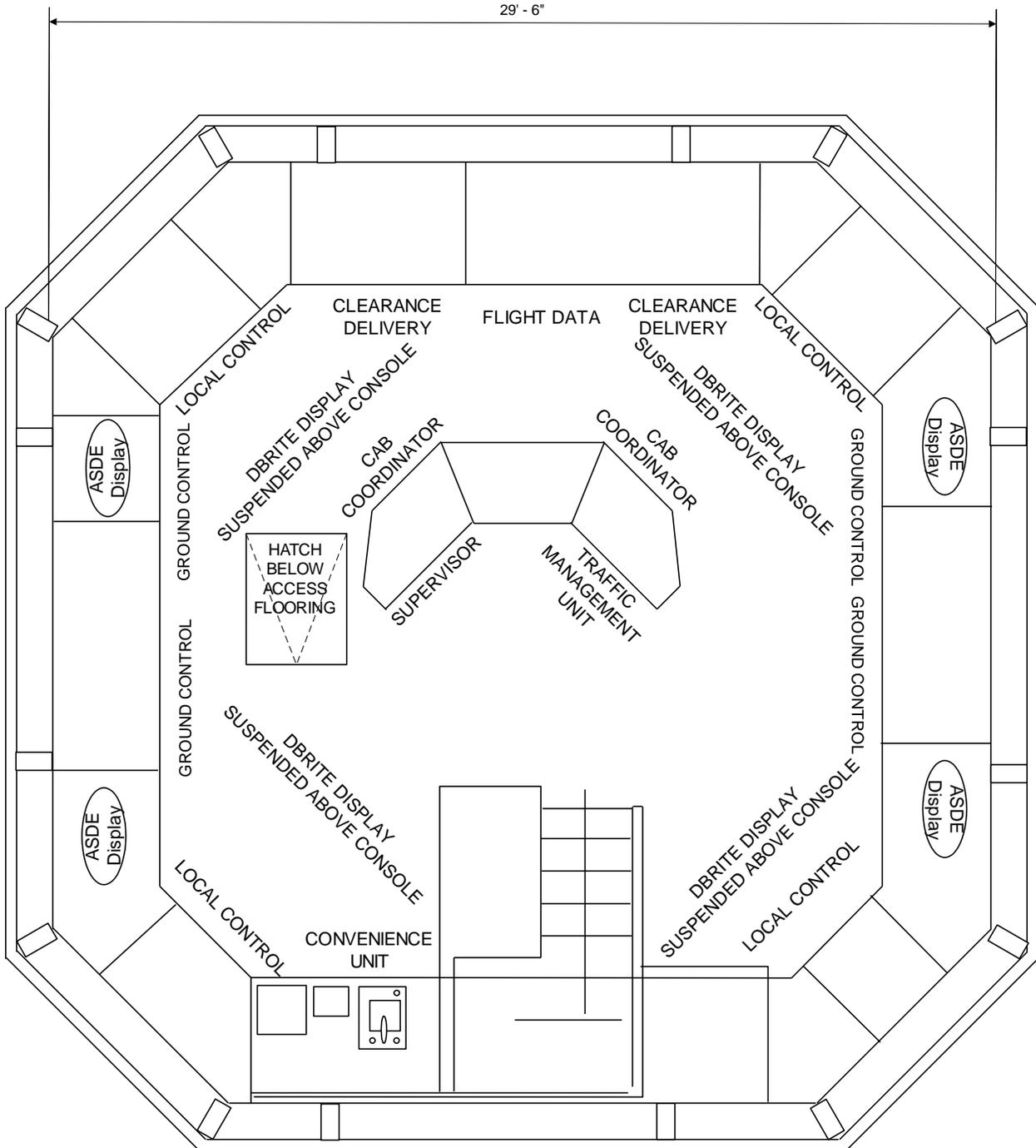


FIGURE 7. 850 SF STANDARD MAJOR ACTIVITY CONTROL CAB LAYOUT

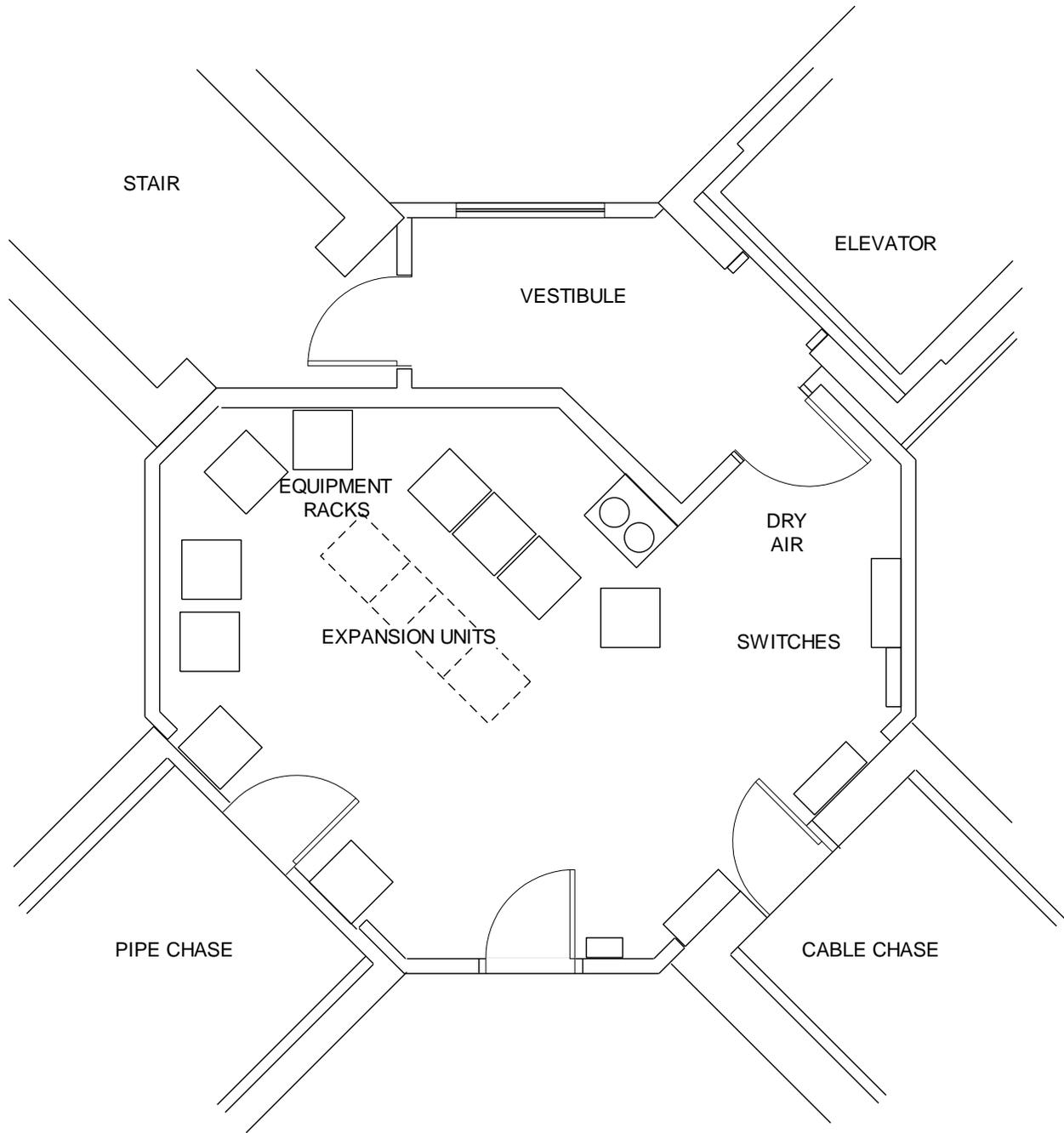
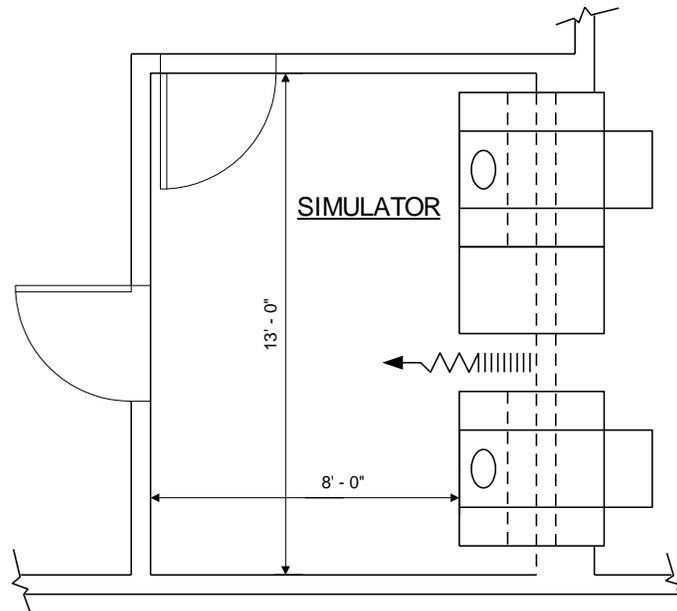
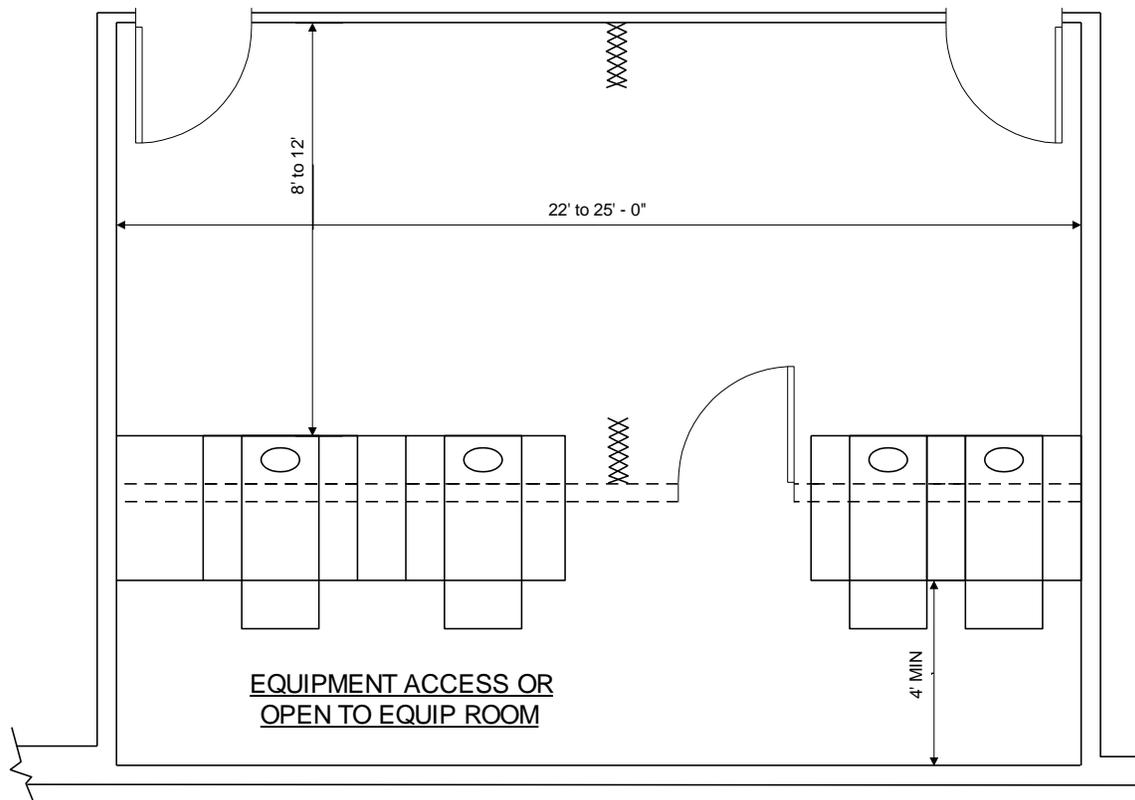


FIGURE 8. ASDE-3 EQUIPMENT IN MAJOR ACTIVITY LEVEL ATCT LAYOUT



CLASS A TARGET SIMULATOR PLAN



CLASS B TARGET SIMULATOR PLAN

FIGURE 9. TECHNICAL SPACE LAYOUTS

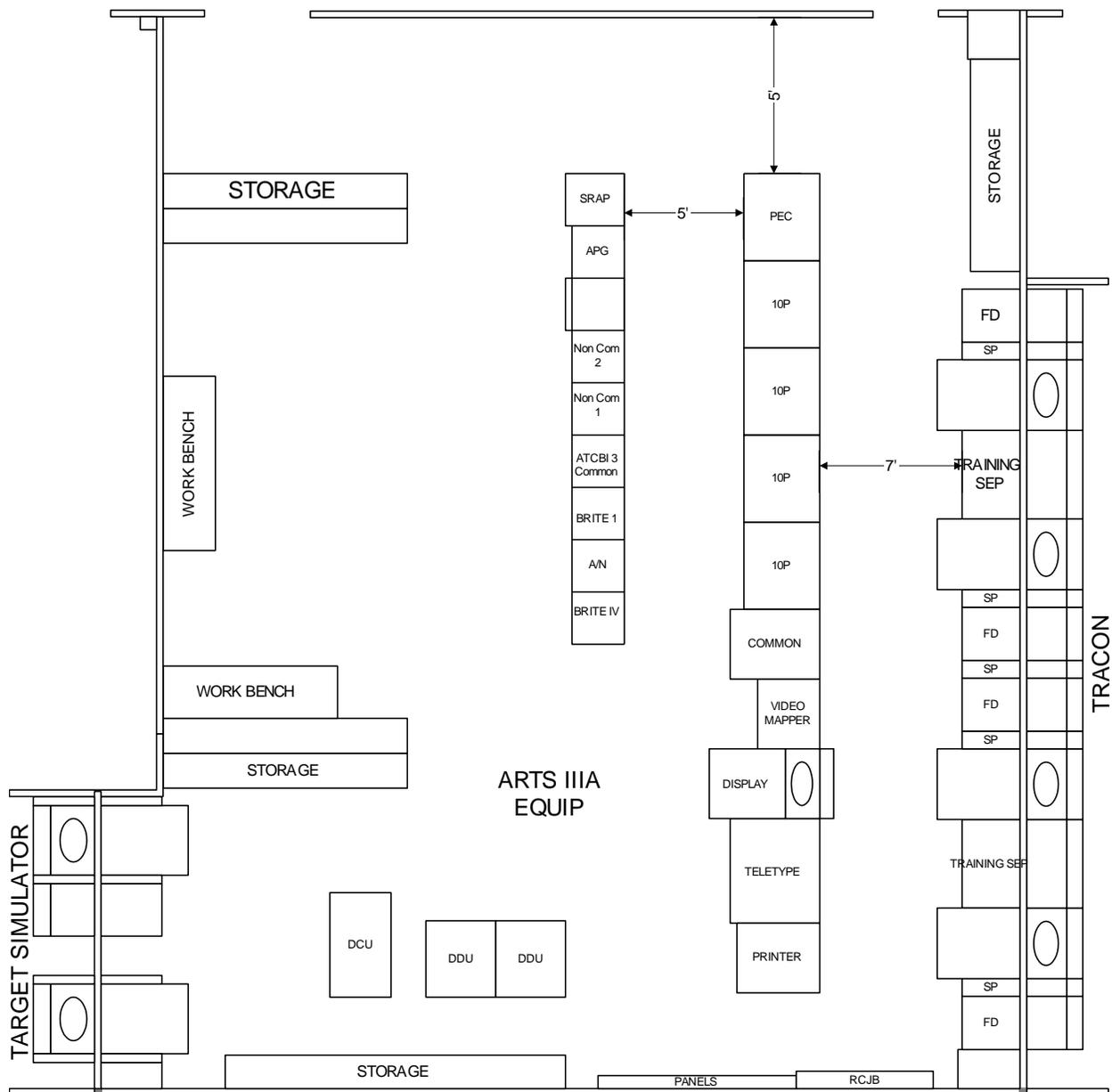


FIGURE 10. TECHNICAL SPACE LAYOUTS

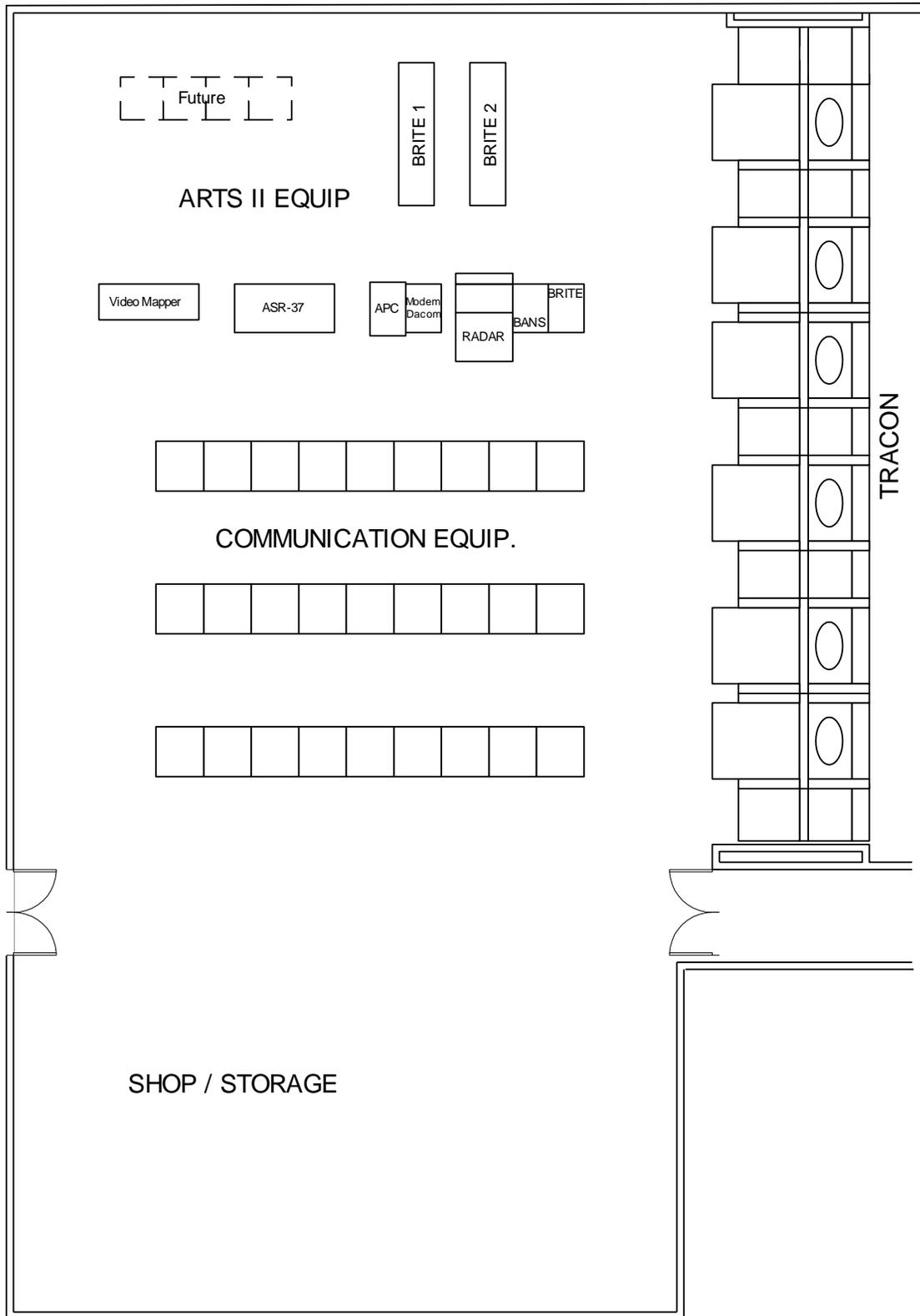


FIGURE 11. ARTS IIIA EQUIPMENT ROOM LAYOUT

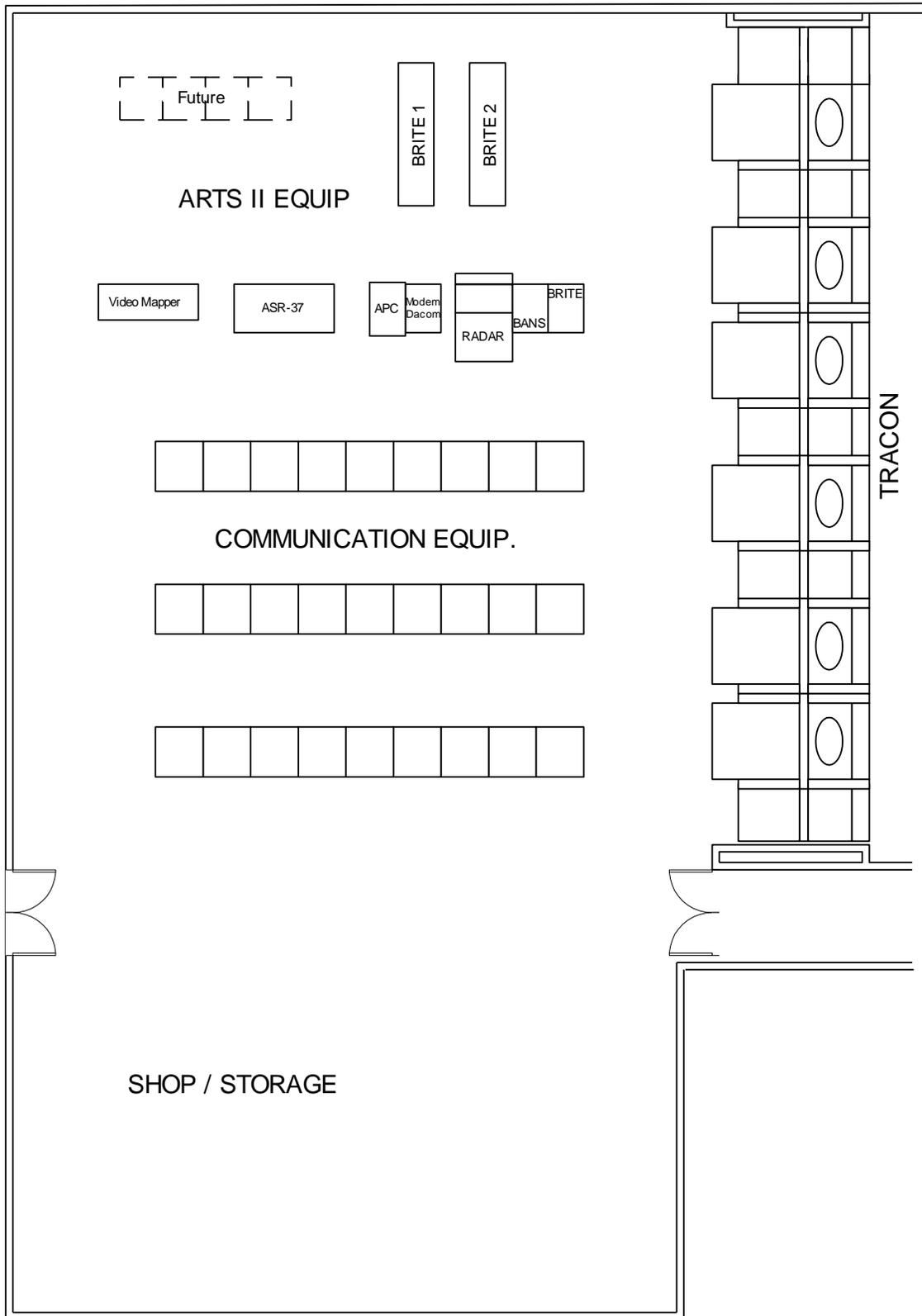


FIGURE 12. ARTS II TRACON EQUIPMENT ROOM LAYOUT

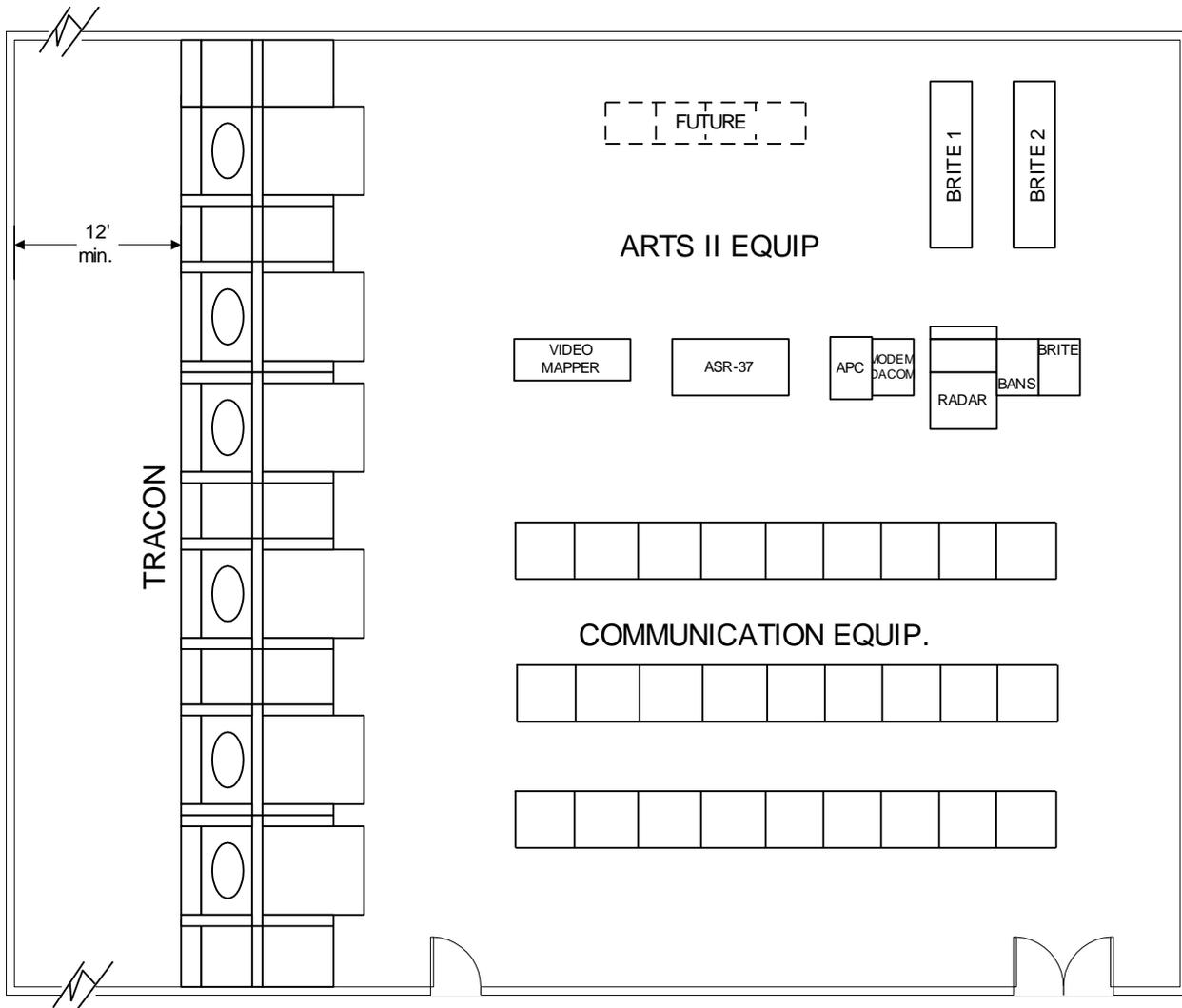


FIGURE 13. MINIMUM ARTS II TRACON OPERATIONS ROOM LAYOUT

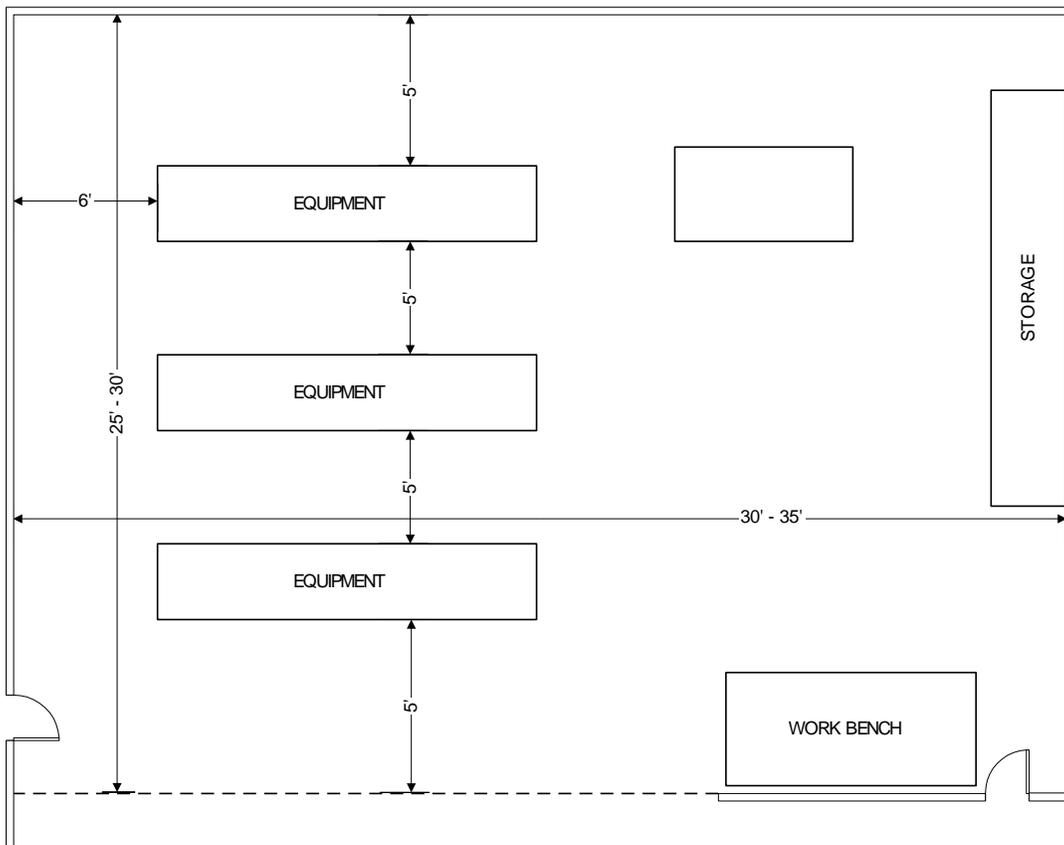
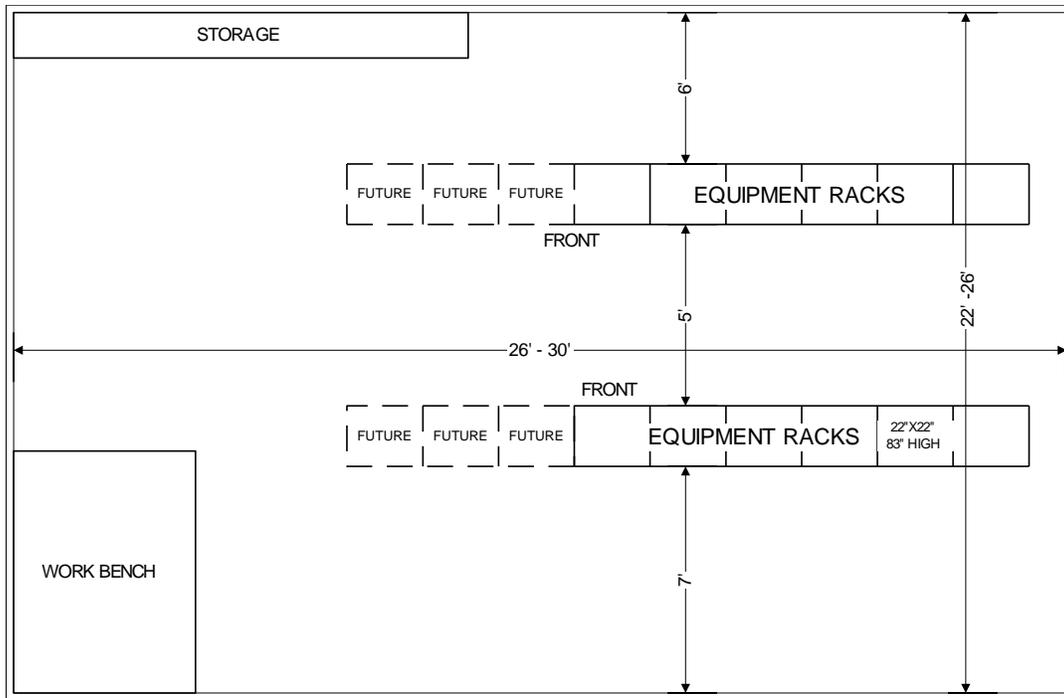


FIGURE 14. REPRESENTATIVE COMMUNICATIONS EQUIPMENT ROOM LAYOUTS

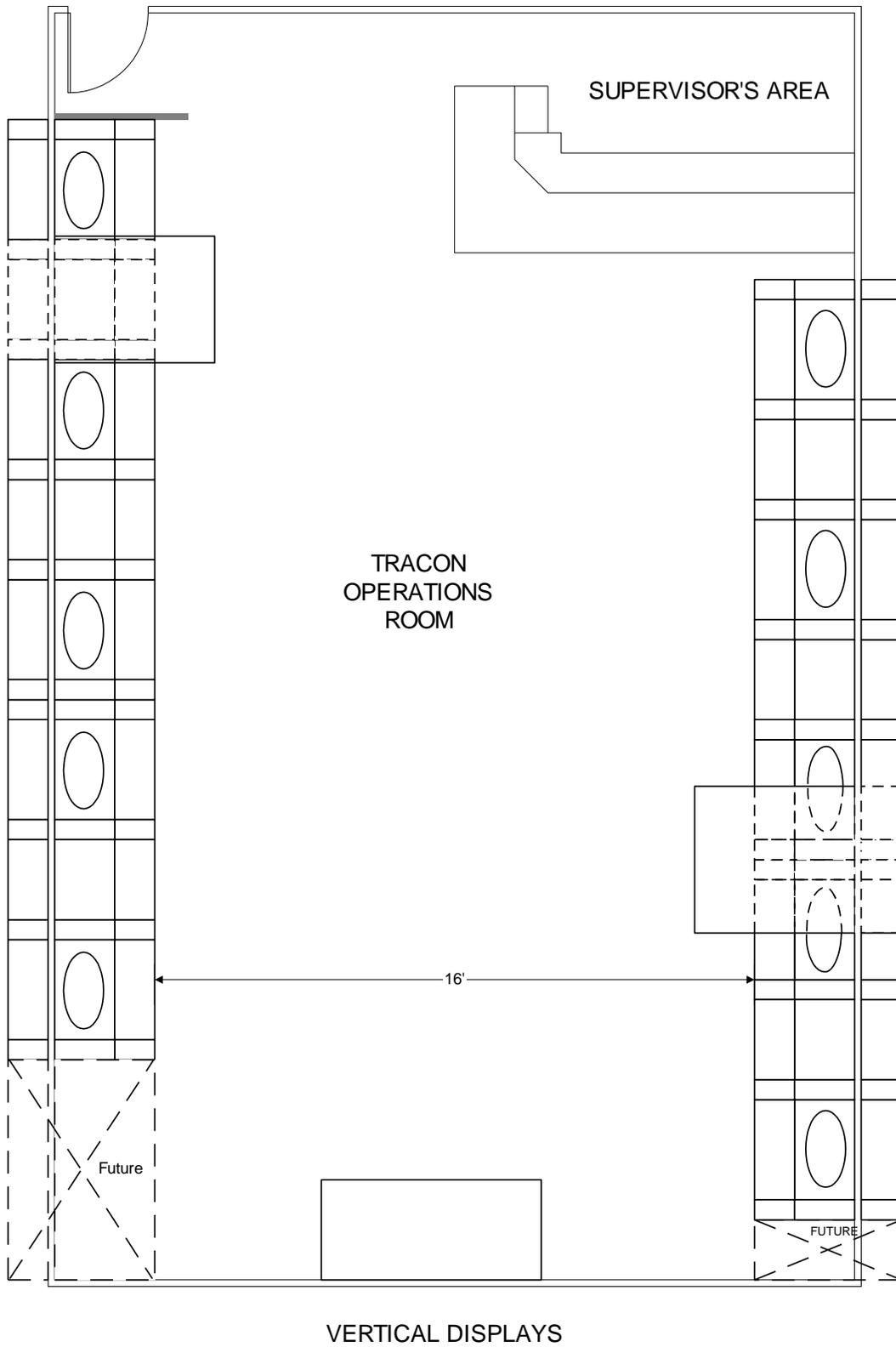


FIGURE 15. MAJOR ACTIVITY TRACON OPERATIONS ROOM LAYOUTS

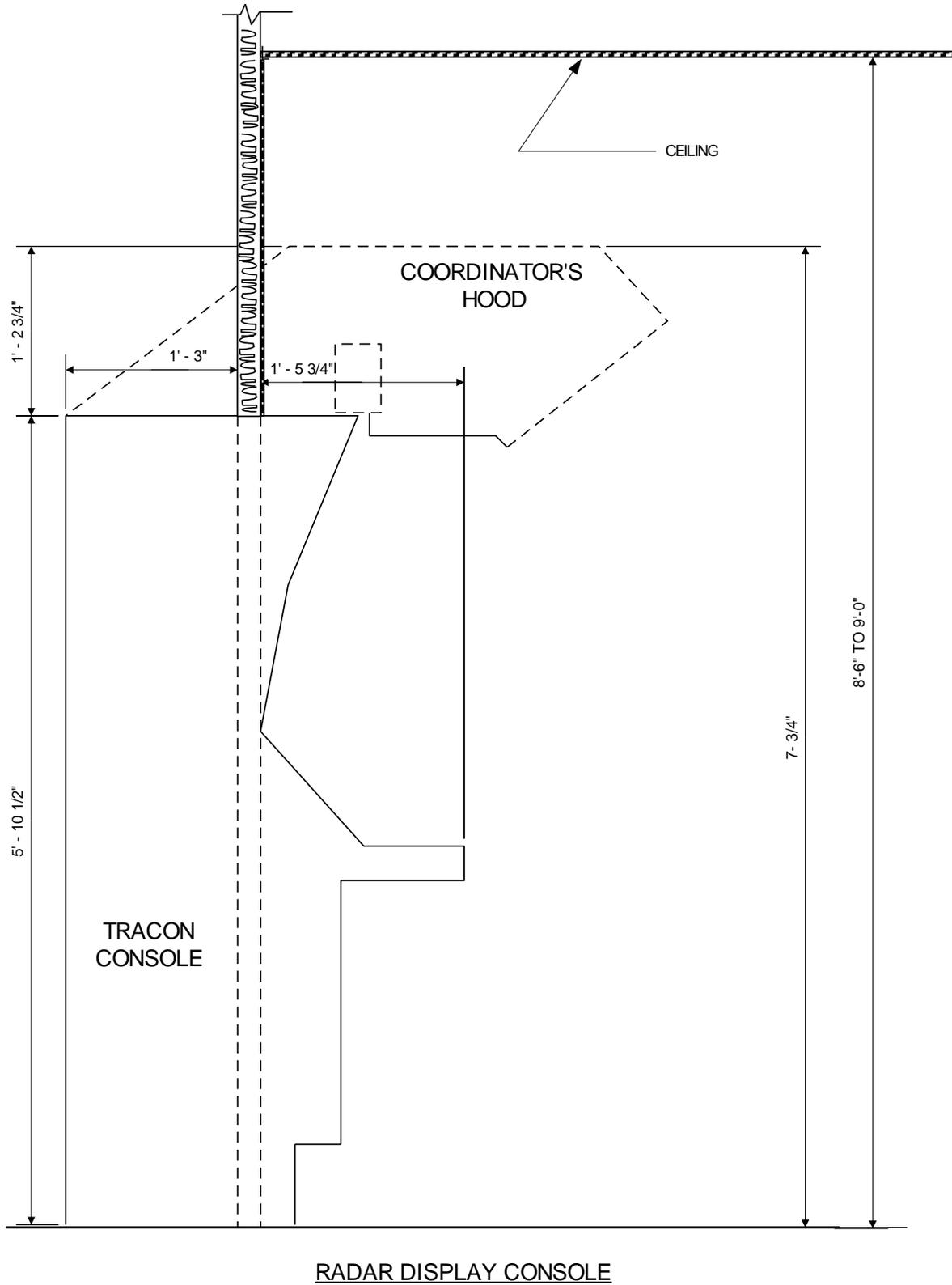


FIGURE 16. RADAR DISPLAY CONSOLE

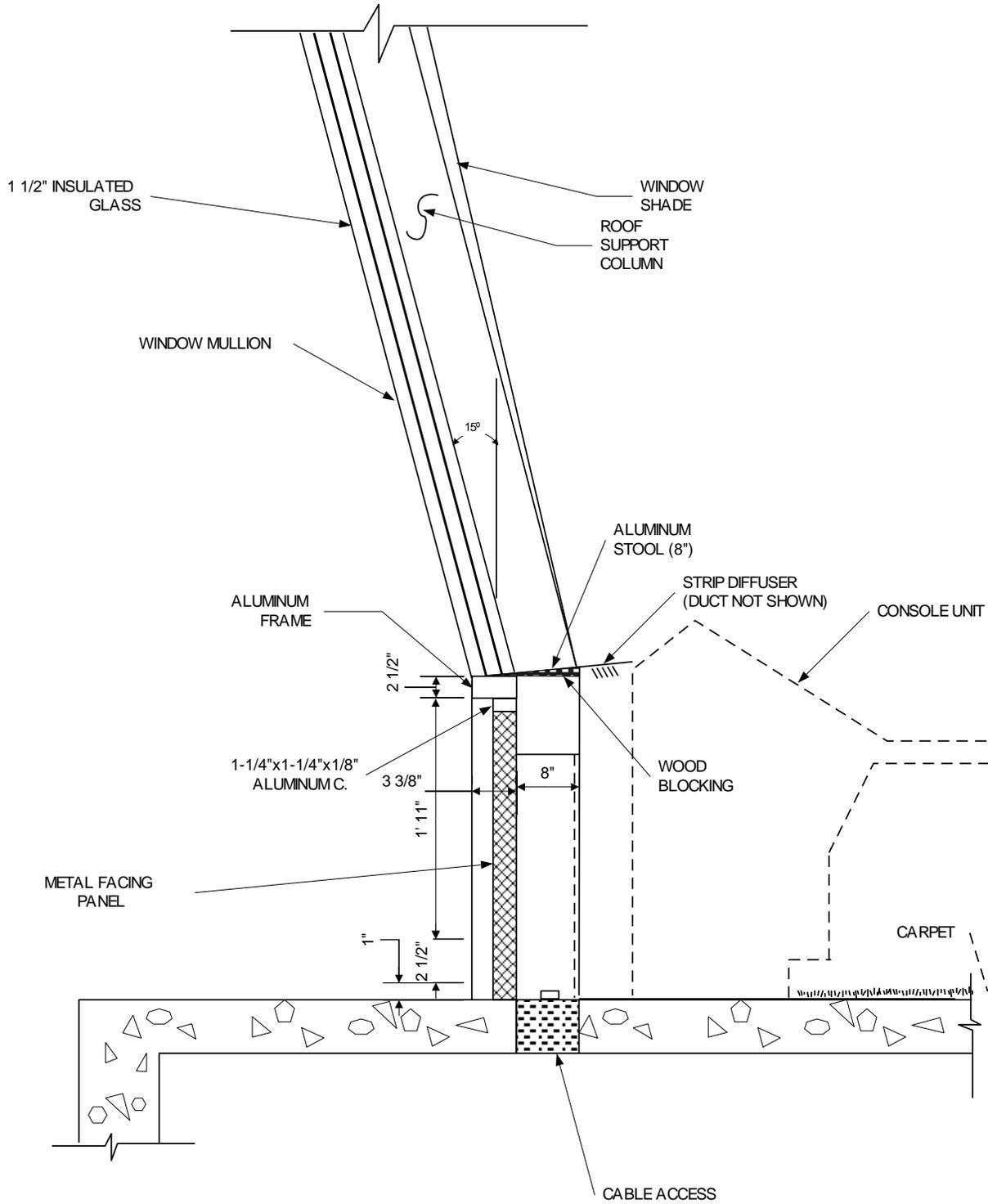


FIGURE 17. REPRESENTATIVE CAB SILL AND WALL SECTION

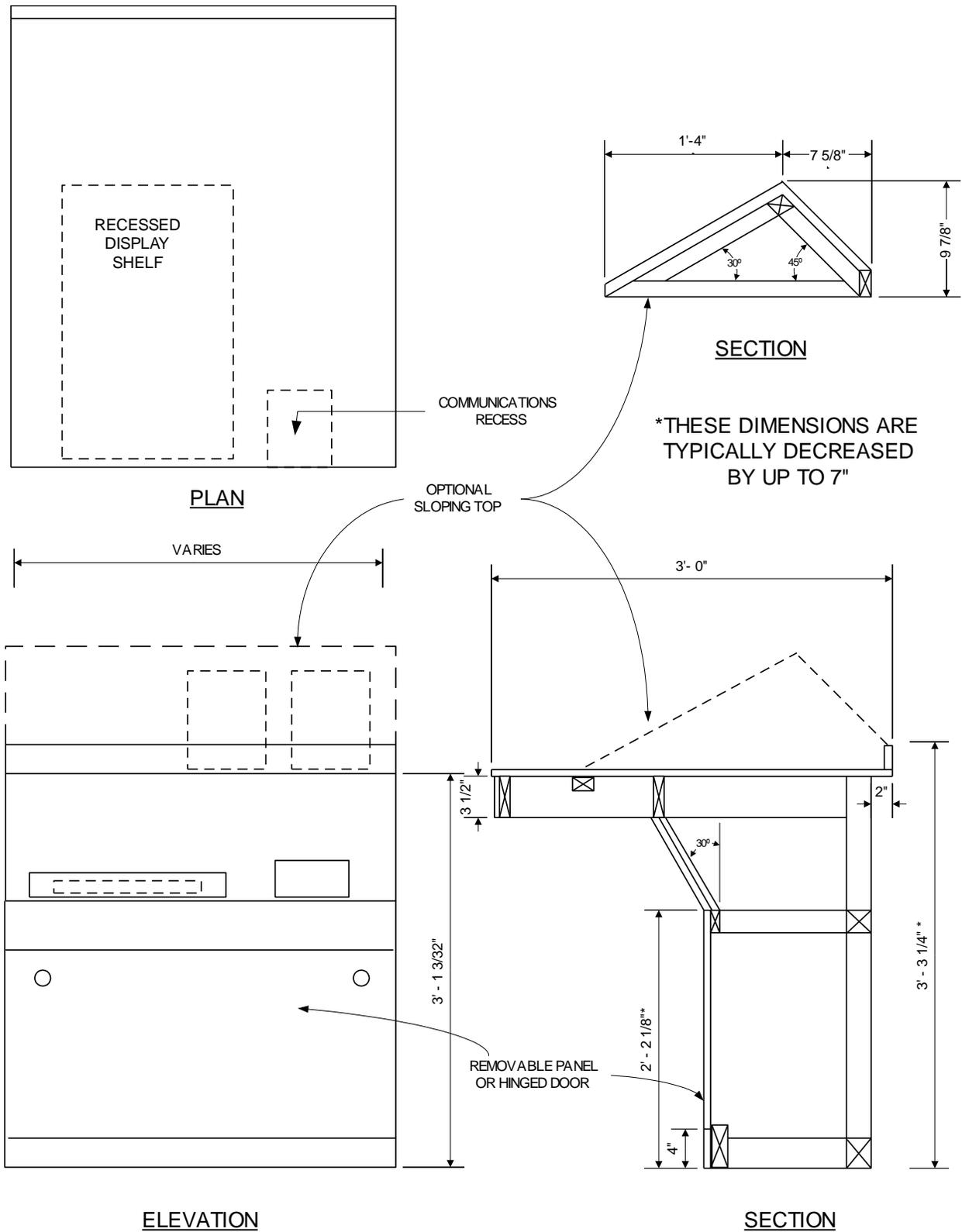


FIGURE 18. TYPICAL CAB CONSOLE

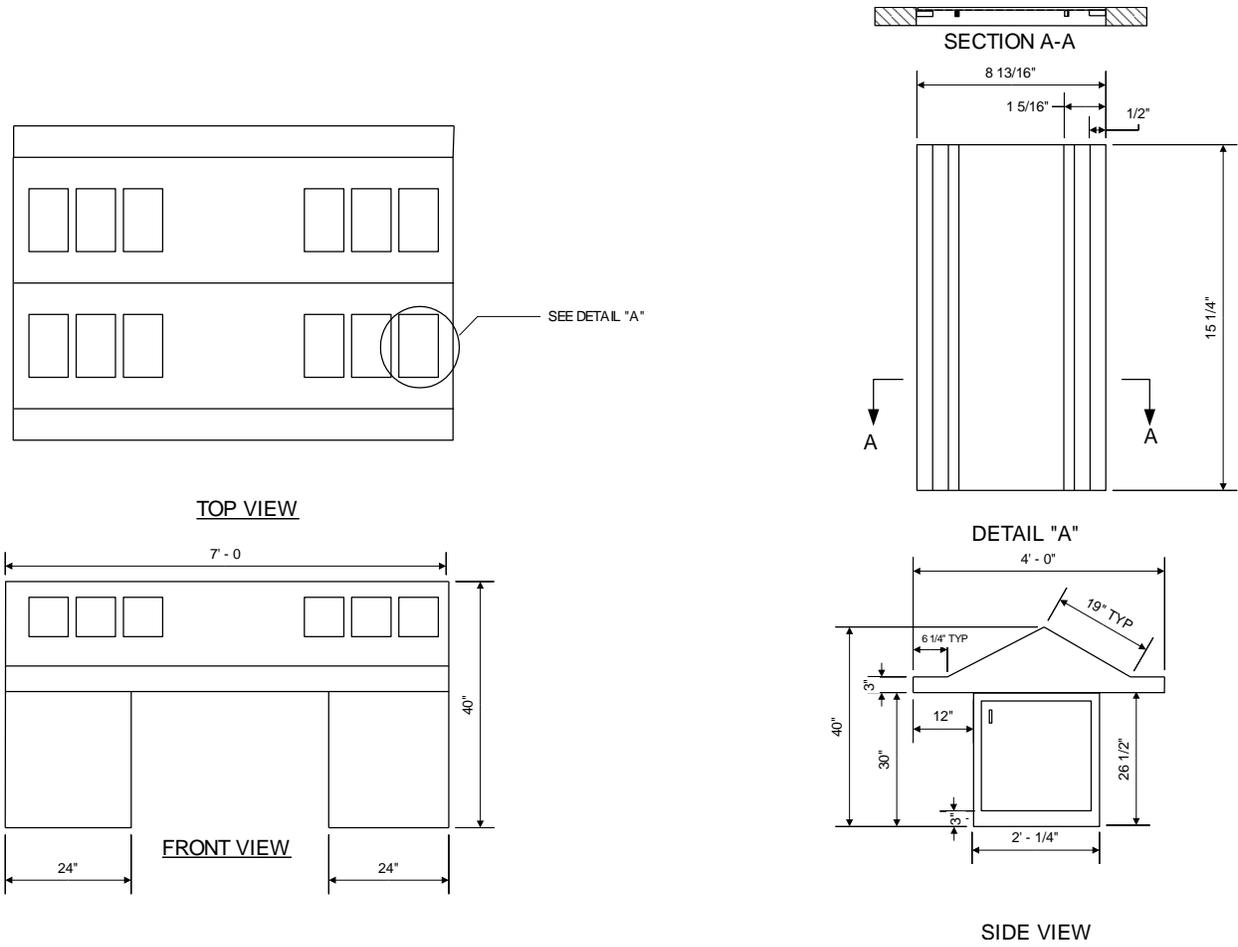
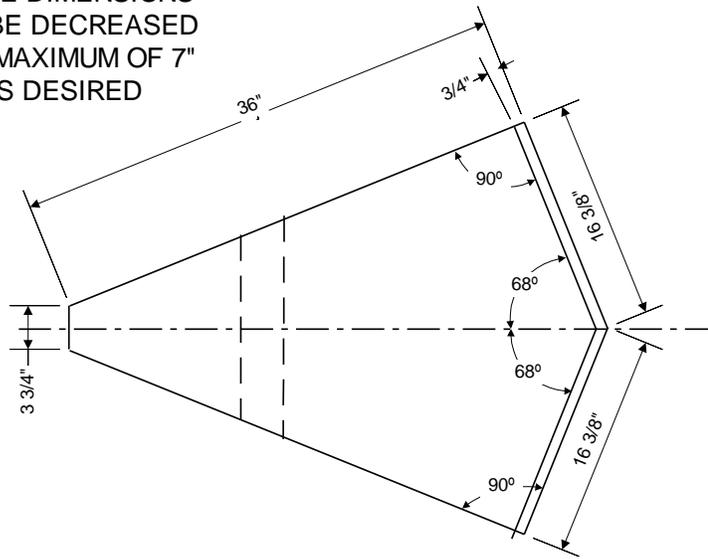
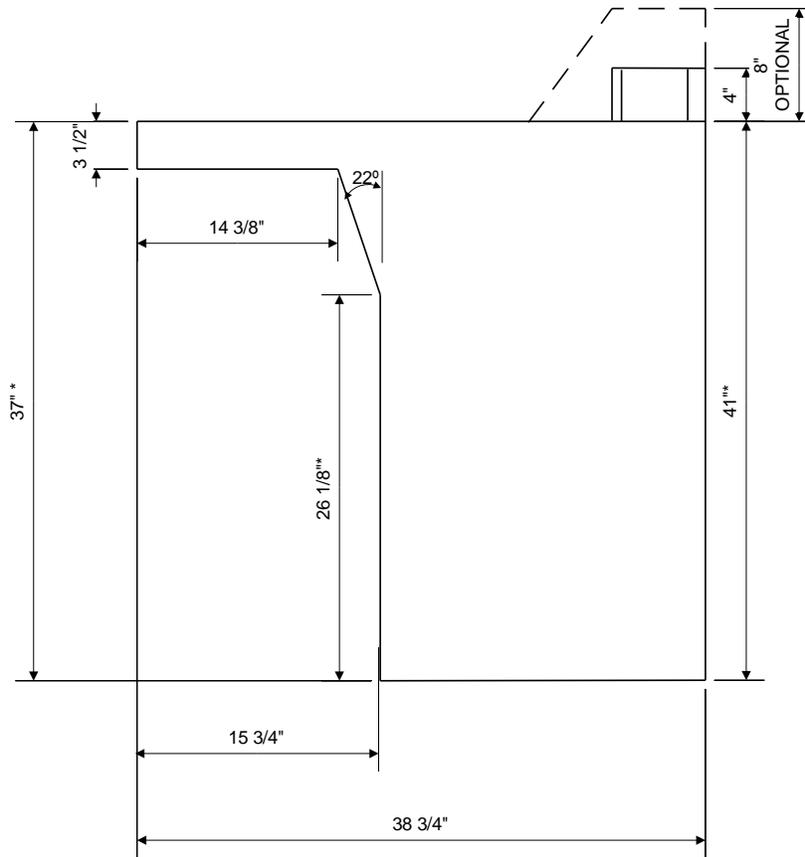


FIGURE 19. ISLAND CONSOLE

*THESE DIMENSIONS
MAY BE DECREASED
BY A MAXIMUM OF 7"
AS DESIRED



TOP VIEW



SIDE VIEW

FIGURE 20. CORNER CONSOLE WITH HORIZONTAL EQUIPMENT PANEL

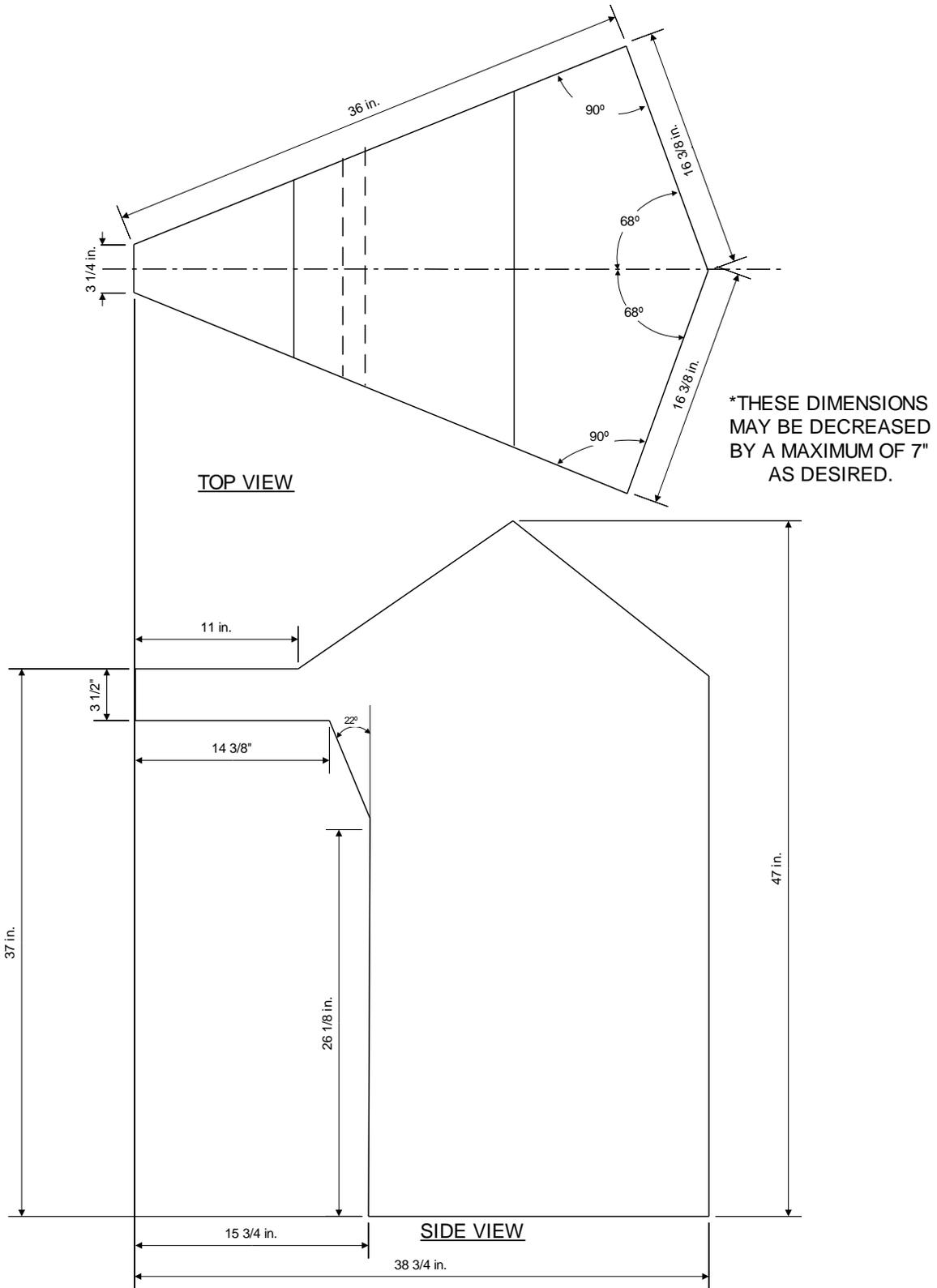
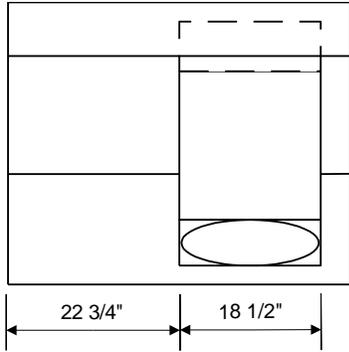
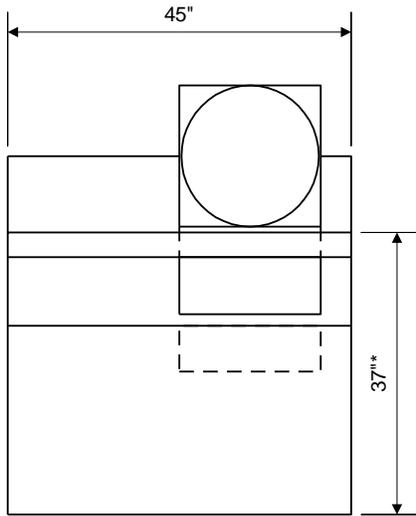


FIGURE 21. CORNER CONSOLE WITH SLOPING EQUIPMENT PANEL

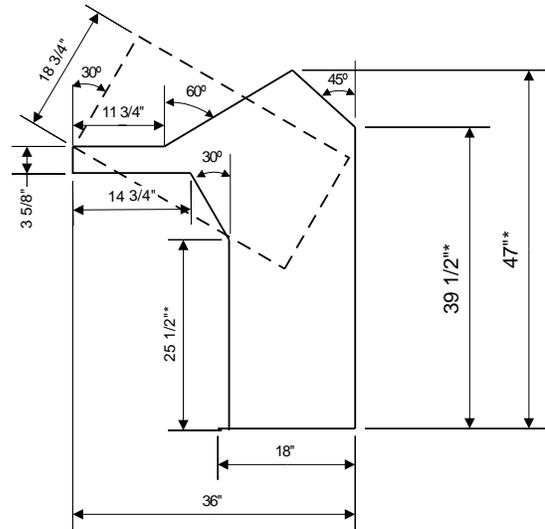


TOP VIEW



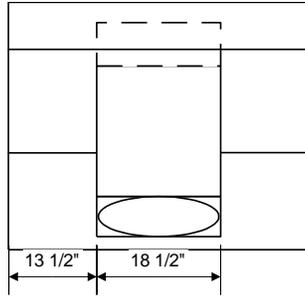
FRONT VIEW

* THESE DIMENSIONS MAY
BE DECREASED BY A
MAXIMUM OF 7" AS
DESIRED.



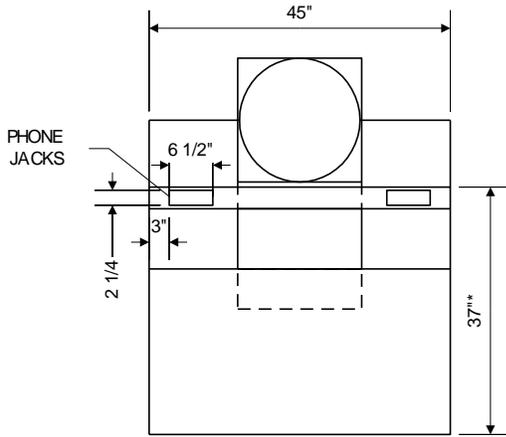
SIDE VIEW

FIGURE 22. BRITE ASR CONSOLE

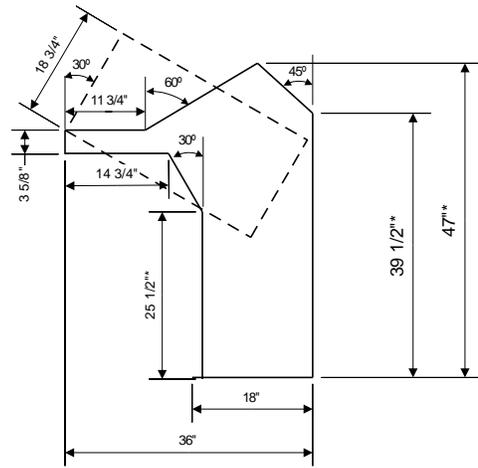


TOP VIEW

* THESE DIMENSIONS MAY
BE DECREASED BY A
MAXIMUM OF 7" AS
DESIRED.



FRONT VIEW



SIDE VIEW

FIGURE 23. BRITE ASDE CONSOLE

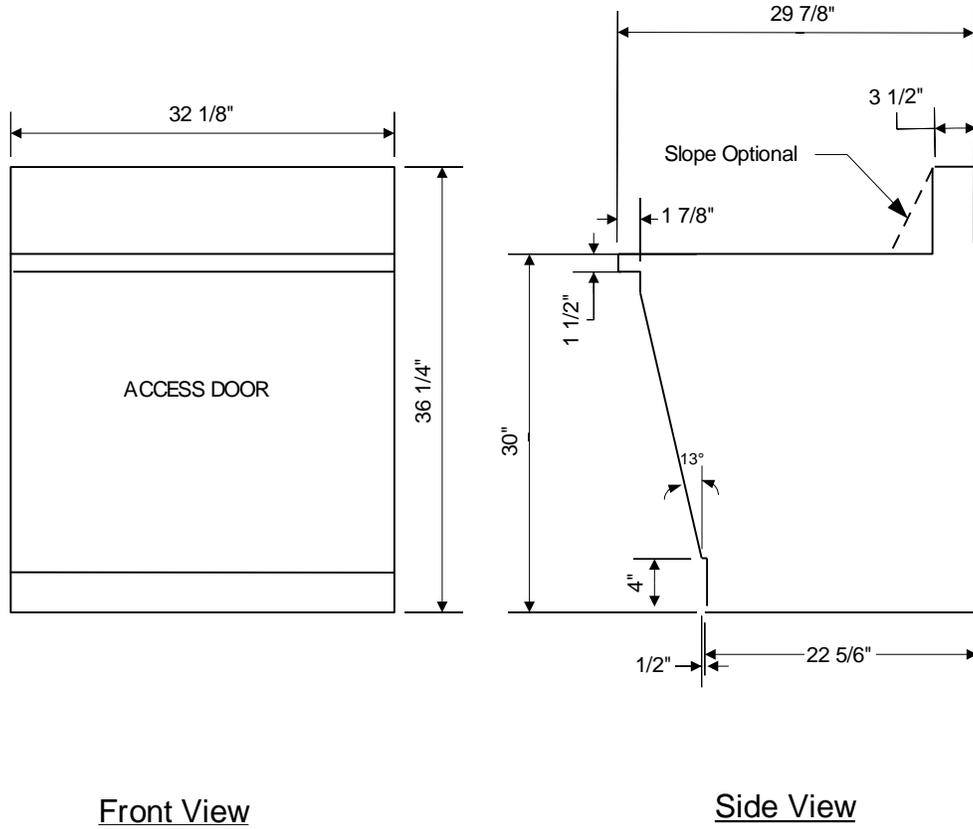
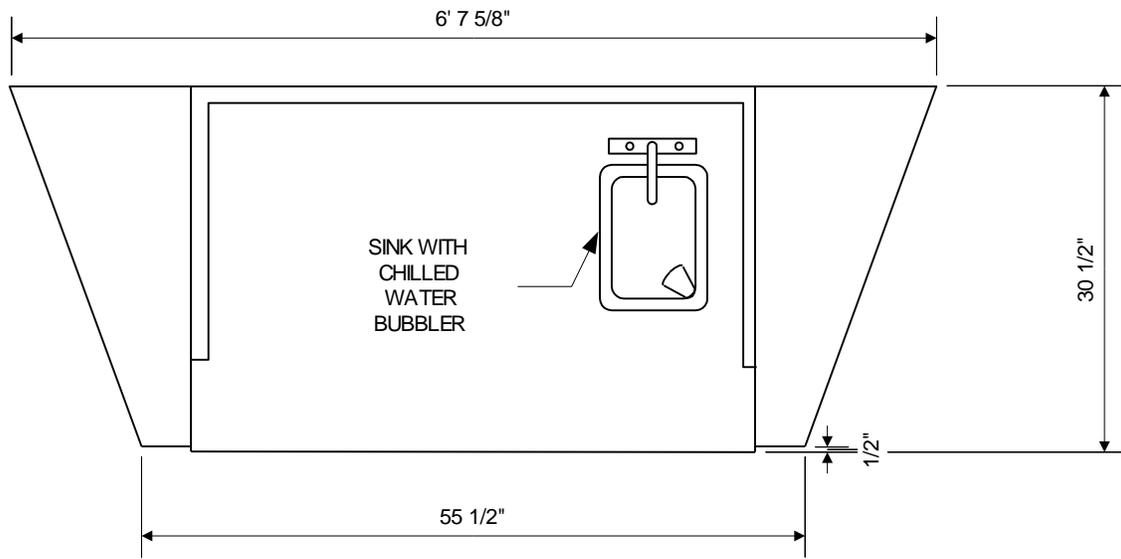
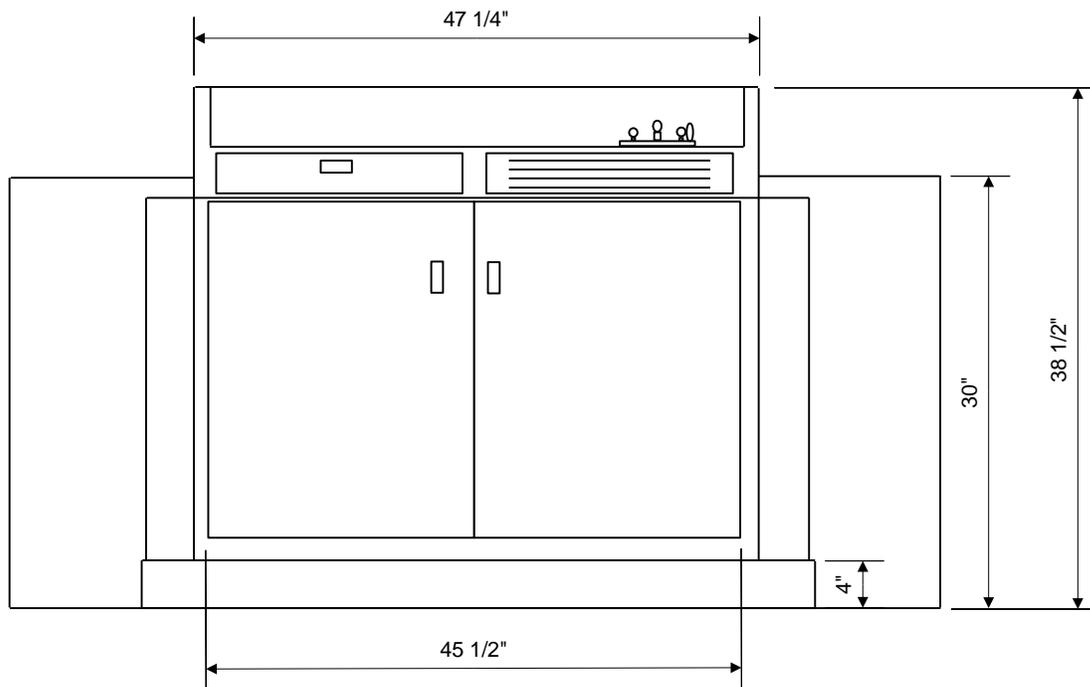


FIGURE 24. FLIGHT DATA ENTRY PROCESSOR CONSOLE (FDEP)



TOP VIEW



FRONT VIEW

FIGURE 25. CONVENIENCE UNIT

APPENDIX 4 ABBREVIATIONS

AASHTO - American Association of State Highway and Transportation Officials

A/C - Air Conditioning

AC - Alternating Current

ACC – Area Control Center

ACE-IDS - ASOS Controller Equipment (ACE)/ Integrated Display System (IDS)

ACI - American Concrete Institute

ACT - FAA Technical Center

A&E Architect and Engineering Firm

AF - Airway Facilities

AFM - Air Force Manual

AFTIL-Airway Facilities Tower Integration Laboratory

AGL - Above Ground Level

AIC - Amperes Interrupting Current

AISC - American Institute of Steel Construction

ALS - Approach Light System

AMS – Acquisition Management System - FAA

ANI SOP - NAS Implementation Program Standard Operating Procedures

ANSI - American National Standards Institute

ARI - American Refrigeration Institute

ARMS - Airport Remote Monitoring System

ARSR - Air Route Surveillance Radar

ARTS - Automated Radar Terminal System

ASCE - American Society of Civil Engineers

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ASDE - Airport Surface Detection Equipment

ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers

ASME - American Society of Mechanical Engineers

ASOS - Automated Surface Observing System

ASR - Airport Surveillance Radar

ASTM - American Society for Testing and Materials

AT - Air Traffic

ATC - Air Traffic Control

ATCBI - Air Traffic Control Beacon Interrogator

ATCT - Airport Traffic Control Tower

ATIS - Automatic Terminal Information Service

AWG - American Wire Gauge

AWOS - Automated Weather Observation System

AWS - American Welding Society

BCAB - Bare CAB

BOCA - Building Officials and Code Administrations

BOMA- Building Owners and Managers Association

BRITE - Bright Radar Indicator Tower Equipment

BWM - Bandwidth manager

CAB - Control Cab

CBA - Cost Benefit Analysis

CBEMA - Computer and Business Equipment Manufacturers Association

CBI - Computer Based Instruction

CCTV - Closed Circuit Television

CFC - Chlorofluorocarbon

CFM - Cubic Feet per Minute

CFR - Code of Federal Regulations

CMA - Central Monitoring Agency

CMC - Central Maintenance Computer

CMS - Centralized maintenance system

CMU - Concrete Masonry Unit

COMM - Communication

CONRAC – Brand name of a monitor used for the Tower Radar Display

CPDS - Critical Power Distribution System

CSU/DSU - Channel Service Unit/Data Service Unit

DASI - Digital altimeter setting indicator

DBRITE - Digital Bright Radar Indicator Tower Equipment

DC - Direct Current

DCU - Disk Control Unit

DDC - Direct Digital Control

DDU - Disk Drive Unit

DMN - Data Multiplexing Network

DoD - Department of Defense

DoE - Department of Energy

DoT - Department of Transportation

DPU - Data Processing Unit

DSO – Data Systems Officer

DSS – Data Systems Specialist

DVRS - Digital voice recorder system

DX - Direct Expansion

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EARTS - Enroute Automated Radar Tracking System

ECMS - Environmental Control and Monitoring System

EDDA - Environmental Due Diligence Audit

EES - Earth Electrode System

EI - Employee Involvement

EIA - Electronic Industries Alliance

EMI - Electromagnetic Interference

EMT - Electrical Metallic Tubing

EPA - Environmental Protection Agency

EPDS - Evaluation and Professional Development Specialist

ESR - Emergency Service Rack

ETG - Electronic Target Generator

ETMS - Enhanced Traffic Management System

FAA - Federal Aviation Administration

FAA-STD - FAA Standard

FAR - Federal Aviation Regulation

FAST – FAA Acquisition Management System Toolset

Fc - Foot Candle

FCT - FAA Contract Tower

FDEP - Flight Data Entry and Printout Equipment

FDIO – Flight Data Input/Output

FIPS - Federal Information Processing Standards

FRDB - Facility Requirements Data Base

FSR - Full Service Rack

GFE - Government Furnished Equipment

GPW - General Purpose Workstation

GSA - General Services Administration

HEPA - High Efficiency Particulate Air

HID - High Intensity Discharge

HPS - High Pressure Sodium

HVAC - Heating, Ventilating, and Air Conditioning

IBAG - Interface Buffer Adapter Generator

IBC- International Building Code

IEEE - Institute of Electrical and Electronic Engineering

IES - Illuminating Engineering Society

IFR - Instrument Flight Rules

IGV - Inlet Guide Vanes

ILS - Instrument Landing System

IOP - Input Output Processor

IOPB - Input-Output Processor "B"

IPC - International Plumbing Code

IPDS - Integrated Product Development System

IRMA - Insulated Roof Membrane Assembly

ITWS - Integrated Terminal Weather System

kAIC - Kiloampere Interrupt Current

kV - Kilovolt

kVA - Kilovolt-ampere

kW - Kilowatt

kWh - Kilowatt-hour

kcmil - Thousand Circular Mils

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APPENDIX 4

LAN - Local Area Network

LAVS - Lavatories

LCU - Link Control Unit

LDRCL - Low Density Radio Communications Link

LED - Light Emitting Diode

LLWAS - Low Level Wind shear Alert System

LPG- Liquid Petroleum Gas

MCM – Thousand Circular Mils; MCM is obsolete terminology for the cross sectional area of a conductor or cable, use kcmil instead.

MCW - Monitoring and Control Workstation

MDP - Main Distribution Panel

MDPC - Main Distribution Panel Critical

MDPCL - Low Voltage Main Distribution Panel Critical

MDPE - Main Distribution Panel Essential

MDPEL - Low Voltage Main Distribution Panel Essential

MDPN - Main Distribution Panel Building Service

MDPNL - Low Voltage Main Distribution Panel Building Service

MDS – Master demarcation system

MDT - Maintenance data terminal

MLS - Microwave Landing System

Modem - Modulator-Demodulator

MPH - Miles per hour

MSL - Mean sea level

MUX - Multiplexer

NAS - National Airspace System

NAVAID - Navigational Aid

NAV/COMM - Navigation/Communication

NC – Noise Criteria

NCMA - National Concrete Masonry Association

NEC - National Electrical Code

NEHRP - National Earthquake Hazard Reduction Program

NEMA - National Electrical Manufacturer's Association

NFPA - National Fire Protection Association

NRCS - National Radio Communications System

O&M - Operations and Maintenance

OD - Outside Diameter

OPS - Operations

OSHA - Occupational Safety and Health Administration

PCAB - Populated CAB

PCS - Power Conditioning System

PDC - Pre-departure Clearance

PDEO - Personnel Development Educational Officer

PEC - Position Entry Cabinet

PNL - Panel or Perceived Noise Level

PPI - Plan Position Indicator

PPO - Planning and Procedures Officer

PSF - Per Square Foot

PSI - Pounds per Square Inch

PSIG - Pounds per Square Inch, Gauge

PV - Photovoltaic

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PVC - Poly Vinyl Chloride

QCT - Quality Control Terminal

RADS - Radar Alphanumeric Display Subsystem

RAPCON - Radar Approach Control (USAF)

RCE - Radio Control Equipment

RCL - Radio Communications Link

RDVS - Rapid Deployment Voice Switch

RF - Radio Frequency

RFDU - Reconfiguration and Fault Detection Unit

RFI - Radio Frequency Interference/Ready for Issue

RML - Radar Microwave Link

RMM - Remote Maintenance Monitoring

RMS – Remote Monitoring System

RRCS - Remote Radio Control System

RVR - Runway Visual Range

RVV - Runway Visibility Value

SCIP - Surveillance and Communications Interface Processor

SCR - Silicon Control Rectifier

SMACNA - Sheet Metal and Air Conditioning Contractors National Association

SOP – Standard Operating Procedures

SOW - Statement of Work

SRAP - Sensor, Receiver, and Processor

SRG - Signal Reference Grid

SSRBDS - Solid State Radar Beacon Decoder System

STARS – Standard Terminal Automation Replacement System

STD - Standard

TDLS - Terminal Data Link System

TCW - Terminal Controller Workstation

TDWR - Terminal Doppler Weather Radar

TED Touch Entry Device

Telco - Telephone Company

TIA - Telecommunications Industry Association

TIDS - Terminal Integrated Display System

TML - Television Microwave Link

TMU - Traffic Management Unit

TRACAB - Terminal Radar Approach Control (within a cab)

TRACON - Terminal Radar Approach Control

TML - Television Microwave Link

TTY - Teleprinter/Teletype/Teletypewriter

TVSS - Transient Voltage Surge Suppressor

UCR - Unsatisfactory Condition Report

UFAS - Uniform Federal Accessibility Standards

UL - Underwriters Laboratory

UPS - Uninterruptible Power Supply

UHF - Ultra High Frequency

UST - Underground Storage Tank

VAV - Variable Air Volume

VDC- Volts DC

VFD - Variable Frequency Drive

VFR - Visual Flight Rules

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VHF - Very High Frequency

VOT - VHF Omnidirectional Test

VSBP - Voice Switch Bypass

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